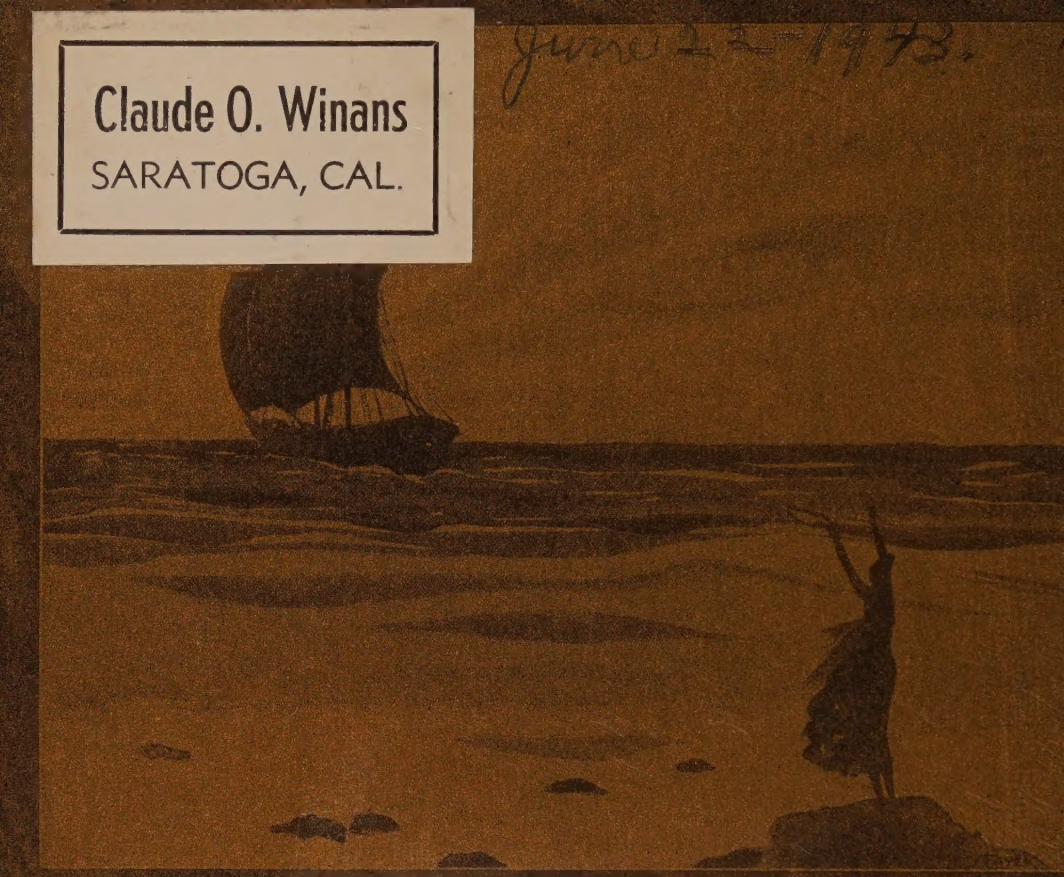
OUTDOOR HERITAGE

Claude O. Winans
SARATOGA, CAL.

June 22-1923.



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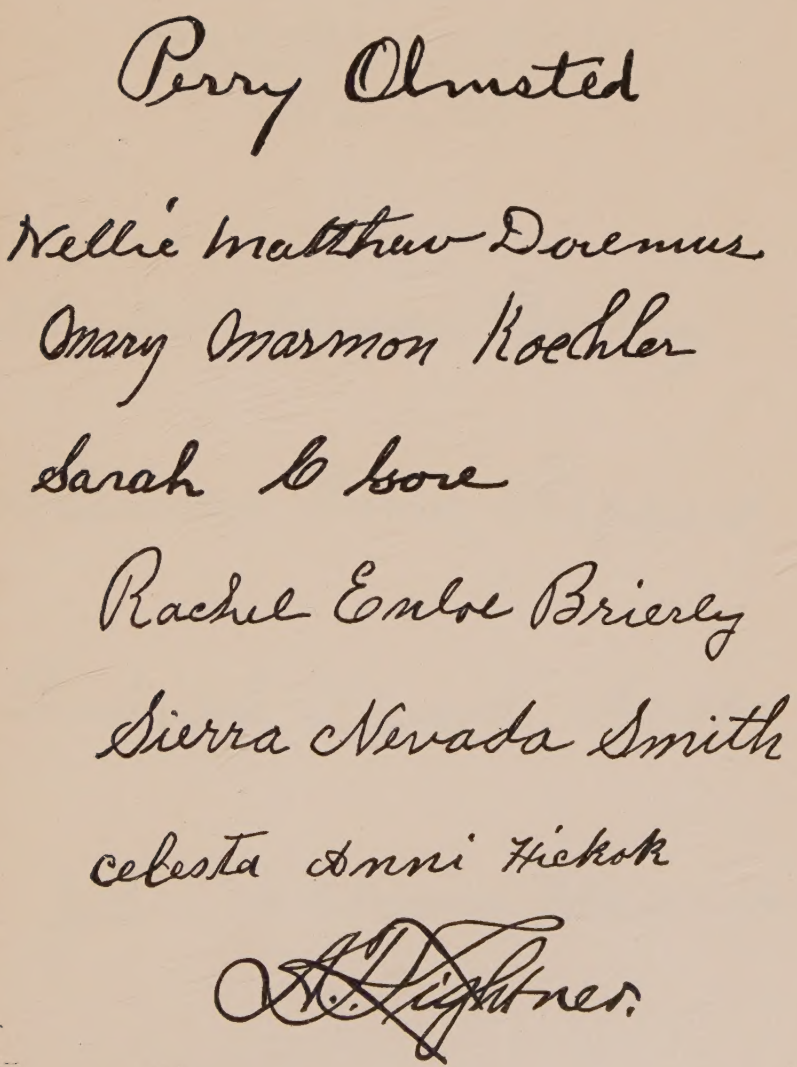

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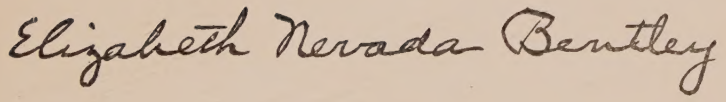
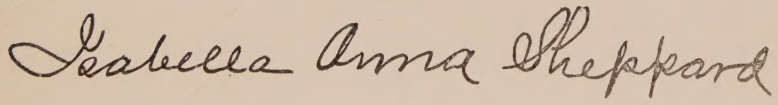
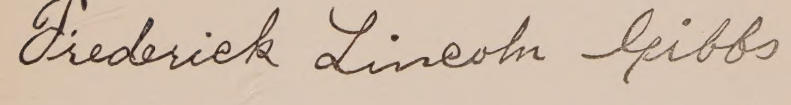
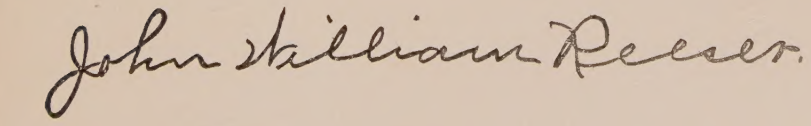
Covered Wagon Babies

Born on the Trail in '48, '49, and the '50's
and in the early '60's, years before the
driving of the Golden Spike
when West met East









Outdoor Heritage

OUTDOOR HERITAGE

By Harold Child Bryant

Instructor, Extension, University of California; in Charge, Yosemite Nature Guide Service; Lecturer and Writer

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PREFACE

Eight years of university training, fourteen years of university research and teaching and twelve years of extension work and nature guiding have forced these two commonplace decisions: 1. Most people love and long for an intimate acquaintance with the out-of-doors and living things. (My lawyer classmates appear to envy my profession of naturalist even with its poor monetary reward.) 2. Few people have opportunity to satisfy completely their innate passion for nature lore. (Schools teach little of it as compared with other utilitarian subjects, city residents lack the chance of first-hand acquaintance with plants and animals and the seeker for knowledge of living things has difficulty in finding it.)

Popular writing on natural history subjects has brought to me wider satisfaction than attempts at technical papers. First, perhaps, because of assurance of a larger and more needy audience and, second, because of an abundance of appreciative letters. "The highest type of scientific writing is that which sets forth useful scientific facts in language which is interesting and easily understood by the millions who read."—L. A. Mann.

As I turn to introspection I am led to say that I love the out-of-doors, have spent much time studying afield and have the urge to stir the interests of others to nature studies.

Thus have I convinced myself of the need for the book here presented and thus have I fortified myself as a fit author for a book of this type.

I am certain that a playground director, had he been writing this book, would have stressed to a greater extent the physical development to be attained through outdoor exercise. An entomologist would have included chapters on various interesting insects of California, and a chamber of commerce secretary would have contributed chapters

typical of the booster literature put in the hands of prospective eastern visitors to our state. You may discover the lack of your own particular interest but I hope you will discover also that I have a deep interest in the vertebrate animal. Certainly I have been most at home in writing chapters which deal with vertebrates. This emphasis should not come amiss to those trained in California schools, since most stress in past years has been put upon microscopic forms of plant and animal life, with a paucity of emphasis upon those larger forms of life visible without the use of a hundred dollar microscope, difficult to carry afield. I have endeavored to choose for description those outstanding forms of life that are typical of various regions and those discoverable along the highways and trails, if one has eyes to see, ears to hear, and a nose to smell, regardless of technical training. At least, I cannot be accused of treating entirely of those subjects dearest to me—the food habits of birds and the conservation of natural resources.

Many a man sits in his office and wishes he were in the open among trees or beside flowing streams. Yet too often the same man out in the forest is afraid and uncomfortable. Both superstition and training have served to "denature" him. To such a man satisfaction will not come from mere visits. What he craves is attained only by real communication with nature. There must be an understanding heart. The understanding heart grows with increasing knowledge of one's surroundings. The following anonymous poem is fitting here:

"A curve in the road and the hillside,
Clear cut against the sky,
A tall tree tossed by the autumn wind
And a white cloud rolling by.
Ten men went along that road
And all but one passed by.
He saw the hill and the tree and the cloud,
With an artist's mind and eye,
And he put them down on canvas,
For the other nine men to buy."

My regret is that I should have to resort to the printed word. Nature's book is open for all to read and it is more inspiring than one set in type. Behind this resort to word pictures is the hope of stirring readers to go afield and "study nature, not books." "If we would know the great truths, we must seek them at the source" (John C. Van Dyke). In spite of surging humanity in choice places we need not seek far to find a real outdoor heritage. It may be found "just under the barbed wire fence" as surely as at the terminus of a long auto trip to the mountains, provided you have trained yourself to find it. "The seeing eye and the thoughtful mind" come nearest to discerning the truth, and bring the highest satisfaction.

George A. Dorsey in *Why We Behave Like Human Beings* says: "Life became a science when interest shifted from the dissection of dead bodies to the study of action in living beings and the nature of the environment they live in." This being true, one may study a life science with few tools. Neither book nor laboratory equipment is necessary. Living things are about us everywhere. With keen insight nature's secrets may be found out. After the first step of observing how animals live comes the more difficult one of philosophizing as to the why of their activities.

In spite of paucity of working time, I do not offer any excuse for errors or misstatements of fact, except those of human frailty and lack of still wider experience, handicaps common to all. Could this be written after twenty more years of experiences afield, it would be richer and more nearly accurate. I do hope that in the sifting of literature I have not been guilty of perpetuating in print any false idea relative to plant or animal life, for I am a lover of accuracy and delight in discomfiting the nature faker. I do realize, however, that what I state as fact may, with the light of future findings, seem far from the truth. The expression, "The truth, we live, to learn," can well be the basis of a long trend of thought.

As I have traveled the length and breadth of the State of California I have found few dull moments. As I analyze

the reason, I am brought to the thought that much of my pleasure has come because I have loved and studied living things from car window, from auto seat, and from closer inspection on foot. Next to my own discoveries have been the repeating of the experiences of others in the field, experiences the knowledge of which came from books. Long before I became acquainted with the yellow-billed magpie I knew of the bird through the charming account by Torrey in his *Field Days in California*. My first meeting with this bird was made rich because of Torrey's recorded experiences which had been available to me. Likewise, I knew of the mountain lady's-slipper for some time before I was able to see one in a Yosemite marsh. Because I had a background of other people's experiences I enjoyed the first meetings the more. My great wish is that the present book may bring to many that same background which has brought such pleasure and profit to me. May these printed words lead many to know first hand, to study and to appreciate, the state's natural resources, and may my words help to fill the mental galleries of others with many a worth-while picture, to be presented at wish, of enjoyable experiences in the open—and may they be in California, my native state.

Berkeley, California, January, 1929.

HAROLD CHILD BRYANT.

FAYER

OUTDOOR HERITAGE

CHAPTER I

How the Land Lies

. . . purple mountain majesties above the fruited plains
—Katharine Lee Bates.

CALIFORNIA IS a state of unusual topographic diversity. The northern two-thirds of the state is characterized by mountains on the coast and a higher range of mountains near the eastern border. These ranges of mountains converge in the extreme northern part of the state at Mt. Shasta, and again in the southern third by the means of the Tehachapi Mountains, enclosing a great central valley. The Sacramento River flows southward through the upper part of this great valley, and the San Joaquin River, flowing northward, drains the southern part. These two rivers unite and pass through Carquinez Strait and San Francisco Bay to the Pacific Ocean. The vast accumulations of alluvial soil washed in by mountain streams furnish rich agricultural land which is being brought under cultivation.

The most characteristic feature of the original central valley was the lack of trees. Groves of oaks and a few other trees were to be found growing on the best soil. Water-loving trees were found along the water courses, but trees avoided the great stretches of adobe and alkali soils and

those where hardpan comes near the surface. Grass and herbaceous plants, however, carpeted the treeless areas and formed a food supply for grazing animals. Only when the surrounding foothills were reached did the plant growth change. Here brush covered every hillside and live oaks showed their heads above the shrubs.

In the Great Valley the soil drinks in the water with unquenchable thirst. During the dry season there is intense heat with resultant drying up of vegetation where natural water supply or irrigation fail to furnish needed moisture. Humidity is low and fields become parched and dry. Yet splendid crops are grown. This is the great granary and garden which supplies food for the state's rapidly growing population.

The only eminence of any size in the whole Great Valley is a series of hills that rise out of the middle of the Sacramento Valley known as the Marysville Buttes. They are volcanic in nature.

Extensive marshes originally occupied the region along the rivers but these have been largely turned into agricultural land through drainage. Reclaimed land at the mouths of the main rivers known as delta land furnishes rich soil. Remaining marshes at the mouth of Butte Creek in the Sacramento Valley, about Suisun Bay, and in western Merced County are chiefly used for duck-shooting preserves.

From forty to sixty-five miles inland the state is mountainous. Peaks vary from 2,000 to 5,000 feet in height. Best known of the peaks in the Coast Range are: Mount Tamalpais, Marin County, 2,604 feet; Mount Saint Helena, Napa County, 4,343 feet; Mount Diablo, Contra Costa County, 3,850 feet; Mount Hamilton, Santa Clara County, 4,209 feet. The highest ridges include the Yolla Bolla Mountains of Mendocino and Humboldt counties, Ben Lomond Ridge of Santa Cruz County, and the Santa Lucia Range which reaches an altitude of 5,600 feet.

The valleys of the Coast Range differ in appearance from the Great Central Valley. In fact, the picturesqueness of the Coast Range is not in the summits and ridges but in its valleys nestled between. The distribution of tree growth is particularly impressive. These valleys have been described as the most park-like in the world. The trees, mostly oaks, grow in clumps as if planted by a landscape gardener.

This is also a fog belt. Especially in the summer, when the interior valleys are sweltering in heat, the north coastal region is covered with a blanket of fog with low temperatures prevailing. These cold fogs cause an actual inversion of life zones. In the Sierra Nevada the coniferous tree belt is above the brush belt. In the northern humid coast region, redwoods and Douglas firs grow in the cañons while chaparral clothes the hilltops. Fog, floating inland, follows the cañons; the hilltops protrude above. A cold current swinging down the coast strikes the continental shelf near Point Arena, and, forming a great body of cold water at the surface of the ocean, presents the right conditions to produce fog. The resultant forest belt extends inland but forty to sixty miles.

The coastal part of the southern third of the State is a plain with low hills; this leads back to a series of mountain ranges some fifty miles east of the coast. Passes traversed by roads and railways prevent isolation of these distinctive areas.

The two ranges, Coast and Sierra, are strongly contrasted in composition, structure and age. The Coast Range is both folded and faulted. It is the many faults still active which produce earthquake shocks. The concealed base of granite is covered with metamorphosed, sedimentary rocks, such as marble, quartzite and schist. Precious metals are largely lacking, but oil is present. In age, the Coast Range is much younger than the Sierra

Nevada. So recent have been the uplifts that the seaward front still shows the successive shore-lines built between the various uplifts.

The Cascade-Sierra Nevada Range comprises a group of high mountains composed largely of granite and other igneous rocks, but nevertheless clothed with vegetation. The folding of the rocks and intrusion of granite have brought about gold-bearing veins, mostly quartz. A long period of erosion has reduced some of these veins, giving auriferous (gold-bearing) gravels. These in some places are covered with lava flows.

In general, there are in California four physiographic provinces: Coast ranges, Pacific valleys, Sierra Nevada-Cascade ranges, and the arid plateaus. Of course, within these provinces are numerous subdivisions, varying according to climate, topography, and soil. Thus, our southeastern deserts are divided by a low range of barren mountains, to the south, the Colorado Desert, low, dry and hot; to the north, the Mojave Desert, a plain of higher altitude interspersed with mountain ranges, some of them high enough to support coniferous forests.

This southeastern desert portion, sometimes termed the "rain shadow area," is characterized by areas of moving sand dunes and almost barren tracts, sparsely covered with such shrubby growth as creosote bush, cacti, and mesquite. Plants here are modified by reduced leaf surface, and storage facilities for conserving moisture.

Climatic conditions in California are peculiar. Moisture-laden winds from the Pacific are cooled by the coastal and interior mountain masses and vapor is condensed. These winds first strike the Coast Range, consequently the north coastal region is noted for its abundant rainfall, in some places averaging sixty inches or more.

As has often been pointed out, in California there are but two seasons, wet and dry. The first rains after the

dry summer turn hills and valleys from brown to a rich luxuriant green. Winter in California is comparable to summer in the eastern United States. Spring is really ushered in with fall rains, for plant life continues to grow and annuals come into bloom in February and March. More flowers are likely to be in bloom in December than in August. Only on the higher mountains does a blanket of snow retard plant growth until late spring.

From the wave-swept beaches, along the coast rise a series of bluffs which, especially to the north, are covered with dense shrubbery. The hills which rise from the bluffs are often grass-covered, affording pasturage for cattle and sheep; evergreen oaks dot the landscape. Then come the forests along the streams and lower edges of the foothills. The valleys stretching between the great ranges are green in winter but parched and dry in summer. Precipitation is concentrated above 6,000 feet in the Sierra; the Great Valley gets but little (on the west side less than ten inches).

On the slopes of the Sierra Nevada, well watered by abundant rainfall and melting snows, stand the great forests for which the state is noted. According to W. L. Jepson, characteristic trees of the various timber belts are as follows:

Foothill belt, 500 to 3,000 feet—Digger Pine, Blue Oak, Interior Live Oak.

Lower portion of main timber belt, 3,000 to 6,500 feet—Yellow Pine, Incense Cedar, Black Oak, Sugar Pine, White Fir, Big Tree.

Upper portion of main timber belt, 6,500 to 9,000 feet—Red Fir, Mountain Pine, Lodgepole Pine, Jeffrey Pine.

Timberline belt, 9,000 to 11,000 feet—White-barked Pine, Mountain Hemlock, Sierra Juniper, Foxtail Pine.

The rocky summits are barren except for dwarf alpine plants, but on the eastern slope the forests reappear, giving way to the sage-brush covered plateau region to the east.

As a result of the variation in climatic conditions, there are characteristic belts of vegetation corresponding to the physiographic features. The Coast Range, especially to the northward, is well forested; the great valleys and foothills are parched and dry, and under natural conditions support only low vegetation and but few trees. The foothills are brush-covered but the middle altitude of the Sierra is wonderfully forested, with types differing from those of the humid coast belt. The longer winters in the higher mountains tend to limit forest growth there to the more hardy trees and on the summits vegetation is limited to a few dwarfed plants. The eastern slope is more arid and poorly forested and the plateau region contains the most arid land found in the United States.

The mild climate of California has permitted the acclimatization of many semi-tropical fruits. The main citrus belt, originally restricted to the Pacific Slope of Southern California, has in recent years been extended northward through the central valley to a latitude equal to that of southern Pennsylvania. Yet altitudinal diversity permits, within the space of one winter day, a dip in the Pacific Ocean under sunny skies, a ride through orange groves loaded with fruit, and a snow-ball fight on a mountainside. Another day could place one on a glacier amid typical Arctic surroundings.

Life Zones

A fair understanding of the life zones represented in the State may be obtained from the following presentation:

It is an obvious thing that certain plants and animals are restricted to certain areas. Redwood trees are found only

in the State of California at the present time; elephants only in Africa and Asia; kangaroos only in Australia. The valley quail is restricted to western North America. The factors concerned in the distribution of plant and animal life as we find them have long been an interesting study to scientists. More careful study shows that within the State of California certain plants and animals have a restricted habitat. The coast redwood is restricted to an area about forty miles wide, extending from southern Monterey County to the Oregon line. One has to climb the highest peaks in the vicinity of Mt. Whitney to see the Sierra mountain sheep. Quaking aspens do not grow on the floor of the San Joaquin Valley, but may be found at elevations of 7,000 feet and upward in the Sierra. The marmot or woodchuck is limited to the higher altitudes in the mountains. Furthermore, it is known that top-knotted jays live only in the forested areas; that meadowlarks prefer open fields at lower elevations. Discoveries of these limitations have led to the plotting of certain life zones.

An airplane journey from Mexico City to the Arctic Ocean would disclose a series of transverse belts of vegetation. The typical Mexican desert over which we would first pass would show mesquite, cactus, and other desert plants. While passing over Southern California, the passenger in an airplane would discover vast areas covered with brush, with a sprinkling of live oaks. On passing Mount Shasta and Southern Oregon the first sizable forest would appear, the most typical tree being the yellow pine. In Washington and Oregon smaller trees, including lodgepole pine and red fir, would be most conspicuous.

Before reaching the main tundra region in north Alaska, a considerable area covered with small sparse growths of jack pines or spruce would be encountered, indicating

timber line. Beyond this, lichens, mosses, and a few stunted willows would alone cover the landscape.

Now the remarkable thing is that the same belts of vegetation to be seen in an airplane journey from Mexico City to the Arctic Ocean may be encountered on a trip from the floor of the San Joaquin Valley to the top of the High Sierra. In the hottest part of the San Joaquin Valley may be found typical desert vegetation, although mesquite and cactus are lacking. Approaching the foothills, one passes through the great belt of brush which the old Spanish Californians called chaparral. At elevations around 3,000 feet one leaves the live oaks and digger pines at the upper end of this brush belt and encounters a great forest of western yellow pine and incense cedar. Altitudes of 8,000 feet disclose lodgepole pine and red fir. Timber line is passed when hemlocks and whitebarked pines are left below, and, as was the case in the northern journey, vegetation found above timber line is made up of lichens, mosses, and stunted willows.

Scientists have named these zones after geographical locations; Lower Sonoran Zone (typical desert); Upper Sonoran Zone (typical brush belt); Transition Zone (a mixed belt characterized by western yellow pine, but having elements from both an upper and a lower life zone); Canadian Zone (lodgepole pine and fir belt); Hudsonian Zone (timber line belt); and Alpine-Arctic Zone (area above timber line).

It takes but little additional study to discover that certain types of animal life are inextricably tied to these life zones. Certain birds, animals and reptiles breed only in the brush belt. There are others restricted to yellow pine forests. Because some kinds of life are usually found within these defined life zones, they are termed indicators. One may be sure he has entered, or is above, the yellow pine belt, if he no longer finds California towhees, typi-

cal of upper Sonoran Zone. One is sure to be in the timber line belt if he discovers the interesting little mammal known as the cony.

Most species of vertebrates are still more limited in their distribution even within the occupied life zones. The California woodpecker feeds almost entirely upon acorns; as a consequence this bird is not found where acorns are not available. Meadowlarks build their homes and find a food supply in open lands, but would be much out of place in a forest. In an attempt to explain the limited distribution of various species of animals one comes ultimately to the following explanation suggested by Dr. Joseph Grinnell:

Birds and animals are located where we find them because they find there:

1. An adequate food supply.
2. Presence of safe breeding places.
3. Presence of temporary refuge from enemies.

Where any one of these important factors is lacking, there is a break in distribution. Each constitutes a necessity; its lack is sufficient to make a vacancy so far as the species under consideration is concerned.

Dr. C. Hart Merriam, who first proposed life zones of this kind, believed that temperature was the main control in the formation of the various conditions indicated in the zonation. In other words, the quantity of heat and the mean temperature of hottest time were supposed to be the controlling factor. Further study has shown that life zones owe their existence to many factors and that the question as to cause is in reality a complex one, involving primarily temperature, humidity, precipitation, and evaporation. Perhaps the one word which comes closest to describing the controlling factor is the word climate.

Modification

Original conditions are being modified rapidly. Much of the coast forest, of which the redwood (*Sequoia sempervirens*) is the most characteristic tree, is still in its natural state, but there has been much cutting near the highways and railroads. As the redwood stump sprouts, a second growth rapidly appears.

The great central valleys with their grassland are now largely under cultivation; much of the land is irrigated and the remainder heavily grazed.

The great chaparral belt of the foothills of the Sierra is little disturbed except for areas cleared for fruit land and as modified by hordes of grazing cattle.

There has been extensive lumbering in the main forest belt, inroads having been made especially on the sugar pine, a tree of greatest commercial value in the Sierran forest. There have been few attempts at reforesting the cutover areas. Most of the mountain districts have been grazed by cattle and many mountain meadows have been modified due to extensive grazing of sheep. Exotic forage plants appear in most unexpected places. Perhaps the least modified areas in the northern part of the state are to be found in Del Norte County and in eastern Siskiyou and Modoc counties in the area known as the "devil's garden." Even these areas are not entirely free of hunters and cattlemen.

The streams of the southern and eastern portions of the Sierra and of Southern California have been diverted for irrigation purposes. Pollution of many streams by sawdust and mine refuse, and to some extent by sewage, is only partly checked by laws. As a consequence, the fauna of some of them is modified.

The Pacific slope of Southern California is now largely under cultivation, and plant and animal life has been

greatly modified. The deserts of the Southwest are also cultivated wherever water is available. Even the most bare and arid portion of the Colorado Desert has been completely changed through agricultural development. The Imperial Valley, second largest valley in the state, reclaimed from the desert, is green with fields of alfalfa and grain. Vineyards and cotton fields spot the landscape. Several thriving towns vouch for the success of the enterprise. Meanwhile, native desert life becomes restricted.

There has been extensive planting of exotic plants and trees in Southern California. Perhaps the most conspicuous trees are various species of eucalyptus and acacia from Australia and the pepper tree from South America. Forage plants in wide variety have been introduced and many of them are now considered weed pests—for examples, Johnson grass and Bermuda grass.

Among exotic vertebrates now thoroughly acclimated are three species of rats, the house mouse, Tennessee opossum, English sparrow, and ring-necked pheasant, the latter purposely introduced as a game bird. The opossum, introduced by accident in both southern and central California, is already becoming a serious pest. Several attempted introductions of game species have proved failures.

In the streams are to be found many introduced species of fishes, including two kinds of black bass, the striped bass, calico bass, crappie, ringed perch, blue-gilled sunfish, shad, carp, two kinds of catfish and four kinds of trout: eastern brook, Mackinaw, Loch Leven and brown. Topminnows have been widely distributed in recent years as a means of controlling mosquitoes.

The areas within the national parks probably come nearest to being preserved in a natural state, for no hunting is allowed; grazing and flower picking are restricted and there is but a slight amount of timber cut. The eighteen

national forests of the state furnish a more limited amount of protection to fauna and flora.

The main coast line of California may be described as a bold line of rocky cliffs, broken by bays and occasional sandy beaches. A reef of rocks usually extends seaward from each headland. In many places a mesa or tableland some fifty feet above sea-level stretches away to the hills, wooded on the north coast, brush-covered on the south coast. Deeply cut gullies traverse this mesa. Both highways and railroads, by bridging these gullies, have developed scenic routes overlooking the ocean.

Several bays well separated are of such size that they form some of the finest harbors in the world. Only two rivers are navigable more than a few miles. These are the Sacramento and San Joaquin, which enter San Francisco Bay through a common mouth. A number of picturesque islands, off shore from twenty-five to fifty miles, are situated in the waters of Southern California. With the exception of one, they have been used largely for the grazing of sheep and goats. One, Santa Catalina Island, has been developed into a notable summer resort. Avalon Bay and surrounding waters teem with strange and beautiful sea life. A combination of glass-bottomed boats and clear water afford a chance to study submarine gardens. The complexity of the state's physiography merits a fuller treatise, but since the author's interest lies in another direction, the reader is referred to the bibliography in the appendix for more complete and satisfying accounts.

Chapter II

CHAPTER II

Mammal Memories

There were giants in the earth in those days.—Gen. 6:4

WHAT LIES ahead? What can we prophesy of the future? More pertinent than discussion of the life on Mars is a discussion of what changes we may expect in the future here on our own planet. When viewed only from the standpoint of the present, the future is largely unknown. But when we can profit by the experiences of the past as well as of the present, then we have some basis for judging the type of change in living forms to be expected in the future.

Man has now learned to lay bare the secrets of the past by studying the rocks and their concealed records of past life in the form of fossils. Antedating any human records by millions of years are those revealed by fossil remains.

Fossils furnish materials useful for interpretation of the world of the present by affording knowledge of the life inhabiting it in the past. As we reconstruct the history of life on the earth we understand better the march of events and the part we play in them. Early history goes so far back into time that what we know as human history, which deals with man, is of small import viewed cosmically. The bones and shells known as fossils have

given, and will continue to give, some of our best understanding of the earth, the laws which govern it, the origin and true nature of the life that inhabits it, and the part man plays in it.

To most people the word fossil brings only a vision of disintegrating bones, dug from the depths of the earth, or crumbly shells imbedded in solid rock. But fossils include any sort of imprint left by prehistoric forms of life. The ancients discovered fossil remains and attempted to explain them by the suggestion that they were uncompleted animals on the day of creation. With additional discoveries came the understanding that they were remains of real animals buried in the rock while it was still mud or sand and before it became hardened. Then came the discovery that these fossils represented animals unlike those living at present. And now we may all believe with the scientist that each layer of rock records its own distinctive forms of life, the oldest below and the most recent above.

Fossil collecting is not a new hobby, judging by a find made in the ancient medical school in Greece, identified with that early physician, Hippocrates. Among the ruins of this school, along with statuary and debris, was found the tooth of a fossil elephant. Fossil remains of the same kind of elephant have been brought to light within a few miles, thus leading to the belief that someone had unearthed this specimen and brought it to the school. This may have been the first fossil collected by man.

Nor is fossil collecting likely to lose in popularity, because of the increasing urge of modern man to know the life of the past and to discover the secrets of creation.[1]

The ease with which an expedition can now uncover worth-while material also makes for continued progress. Instead of being satisfied with a single tooth or bone fragment found in disintegrated material, the present day pa-

[1] *The romance of fossil hunting is well portrayed in articles appearing in the September-October (1926) number of Natural History.*

leontologist utilizes mining operations and disinters specimens in quantity, or hires a steam shovel and removes a whole hill in search of material. This latter method, adopted in an asphalt deposit in Santa Barbara County, brought to light a quantity of valuable fossils, both plant and animal.

There are many museums where one may see exhibits of life, of the past and of the present. In the fossil displays may be seen animal life that once roamed the earth but now does not exist. Huge reptiles known as dinosaurs, mounted in life-like pose, reach the ceiling; elephants, much larger than the present living forms, thrust their tusks forward twelve feet or more; and horses that are pygmies to the living forms display extra toes.

Splendid displays of fossil animals of California are contained in the Museum of History, Science and Art, in Los Angeles, and in the Paleontological Museum at the University of California, Berkeley. This visual evidence of extinct life is wonderfully supplemented by numerous printed bulletins and articles. The most significant of published writings have emanated from the departments concerned at the state university. To the scientist names and comparisons are important and are stressed. The gleanings for my reader will deal little with names and technical descriptions but more with those facts that add to a picture of the animal life of the past.

Paleontologists (students of the old) are the interpreters of the age-long records furnished by the rocks.

Have you ever "bearded" a paleontologist "in his den"? The walls are covered with maps and charts showing the geologic periods, and with reconstructed pictures of prehistoric animals. On the table is a large stone which shows the patient work of a preparator as he has chiseled away fragments of rock and then etched with acid, so as to disclose the contours of bone imbedded in the hard

matrix. Alongside of bones are calipers and millimeter rule showing that careful measurements have been taken. Nearby lie a half dozen bones of similar proportion used in comparison, and on the desk a drawing of a tooth with each projection named. When a skull attracts the attention, it is noted that missing parts have been accurately supplied by the use of plaster of Paris.

"What can a man find of interest in those old decaying bones?" you ask. Yet, if you stop to think, you must admit that the historical evidence with which the paleontologist deals is of a more tangible sort than that contained in the printed or written words upon which the historian of human activities relies.

In spite of the aspersion that fossil hunters become "fossilized," there are few students who have such wide interrelations. A paleontologist must be a geologist, geographer, botanist and zoologist. With such necessarily wide interests, narrowness cannot be an attribute of this type of scientist. One is not surprised, therefore, that the most noted Californian paleontologist of recent years was called to the presidency of the Carnegie Institution of Washington, a position where breadth of vision is necessary.

Sufficient beginning in studies of the history of life has been made in California to allow us glimpses of existence in the more immediate past. Record of life of earlier times, marked by lower groups of animals, is meager compared with that furnished by the eastern United States. The plant record in California is largely that of later periods. No fossils bring us evidence from the age of amphibians, and only two groups of reptiles give intimation of conditions during their supremacy. Even the mammal record is limited to the latter part of the age of mammals, for no remains older than the Oligocene have been found in California.

As a rule search for fossil shells and invertebrate remains need not take us far from home in California no matter where we are located, because the whole Coast Range abounds in fossil shells, giving convincing evidence that water once covered this now mountainous area. Unusually thick sediments in many places furnish abundant material useful in studying the marine forms of life existent in several of the older periods of time, and particularly of the periods from the age of reptiles up to the present. Nautilus-like mollusks of the ammonoid group are found in great variety and in a remarkable state of preservation. Stanford University and the University of California possess fine collections of invertebrate fossils. Studies made by Professor James Perrin Smith and others have contributed much to the knowledge of distribution of lower forms and of climatic changes.

Search for fossil remains of higher animals is more likely to lead one farther afield, to more patient search, to lonely and uncomfortable living conditions, and even to danger and thrilling adventure. What could be more thrilling than to have accompanied Mr. E. L. Furlong, the first explorer of Hawver Cave near Auburn, California, to have hung above a subterranean lake on a dangling rope and paddled another lake on an air mattress? Mr. Furlong thus writes of his experiences: "A perpendicular crevice gives access to the first part of the cave. The opening is partly filled with angular limestone fragments and red dirt to within about eight feet of the top. From the entrance the slopes extend down in a southerly direction for approximately forty feet. At this point two irregular, narrow openings give access to a well-like grotto twelve feet deep. From this grotto a small circular hole leads to the main portion of the cave. To reach this a rope is fastened in the grotto and lowered through the circular opening to a depth of twenty-two

feet. The rope drops vertically, hanging free from the walls of the inner cave, and the lower end is immediately over a small subterranean lake. Near the end of the rope is a narrow tunnel about a foot above the water. This extends south for about six or eight feet, where another pool is encountered. Here a raft, consisting of an air mattress, is called into service, and paddling across the water for thirty feet a landing can be made on a mud-covered bank. From the south edge of the water and running in a southerly direction for approximately fifty feet is a tortuous series of narrow passages leading into grottos of varying dimensions; some of them are very large."

Yet neither danger nor inconvenience has stayed the quest for fossils. Careful removal of bones from asphalt deposits occupied weeks of time, the excavators having to withstand the oily odors, still air, and the intense heat of the tar pits. Explorations on the Mojave Desert have meant days spent in the blistering heat of the desert sun. To these earnest searchers for creation's truth the world owes much.

When we mentally picture the millions of animals that have lived their lives on the earth, and at their death made room for others, we might expect to find fossils as common as rocks. Such is not the case, for as F. A. Lucas has pointed out: "If an animal dies on dry land, where its bones lie exposed to the summer's sun and rain and the winter's frost and snow, it does not take these destructive agencies long to reduce the bones to powder; in the rare event of a climate devoid of rain, mere changes of temperature, by producing expansion and contraction will sooner or later cause a bone to crack and crumble." Therefore, it is the exceptional thing to find remains or indications of extinct animals or plants, for seldom do they lose their lives under circumstances making for preservation through long periods of time. Preservation is dependent upon some con-

dition that will exclude air, such as that afforded by submergence in water or asphalt, or burial in a cave. Under such conditions the agents of decay work much more slowly. Some fossils are mere imprints in rock and others are recognizable after being mineralized.[1]

Even more than in biological science, must resort be made to scientific names for extinct forms of life, since, naturally, common names are lacking. Dr. Lucas, in forestalling criticism for the use of long names, relates the statement of an old lady who said, "The discovery of all of these strange animals does not surprise me so much as the fact that anyone should know their names when they are found."

One of the usual questions put to the student of the zoology of the past is: "How many years ago did these animals live?" Satisfactory answers are impossible because of the difficulty in estimating elapsed time. Estimates of the age of the earth vary from 10,000,000 years to 6,000,000,000 years. You may guess at the elapsed time since dinosaurs ruled the earth as anywhere between 50,000,000 and 60,000,000 years. Similar wide discrepancies occur in estimates of time since the beginning of the age of mammals.

Computation of the elapsed time since ancient animals lived, the number of years their rock-sealed skeletons awaited discovery, is only possible by estimating the time it took to accumulate 8,000 feet of sediment. Let us rather picture such a period as of great length without indicating it in terms of years, which could only be guesswork at best. An attempt to realize the thousands of years concerned does not make a usable concept because such periods are incomprehensible to a being with such a comparatively short span of life.

[1] *Any one interested in a delightful popular account of "Animals of the Past" should read the book of this title by Frederic A. Lucas, and published as Handbook Series No. 4 of the American Museum of Natural History.*

Paleontological Finds

To the hunter of vertebrate fossils a half dozen geographical locations in California are veritable Meccas. First in order of discovery come areas in Shasta County where have been found the notable skeletal remains of fish-like reptiles called ichthyosaurs. Next come cave deposits in Shasta County and Hawver Cave in El Dorado County. Most spectacular of all are asphalt deposits near Los Angeles; also in Santa Barbara and Kern counties. Diatomaceous shales of Southern California, particularly of the Lompoc Valley of Santa Barbara County, have furnished bird and fish fossils; and, of most recent exploration, areas in the Mojave Desert reveal life of a more distant time than that represented in the asphalt.

From these sources have come tons of shells, bones, teeth and even chunks of wood, which under scrutiny of the paleontologist have furnished the evidence for reconstruction of life that was. To the untrained this evidence would mean almost nothing; but the paleontologist, by knowing the form and relationships of bones, pictures the whole from the part. When later comes a more complete skeleton, he has the satisfaction of verifying or correcting his reconstructed picture. The picture remains incomplete because man gathers but scant evidence and much that is gathered is fragmentary, but with each new find the sketch becomes more nearly accurate.

The waters of Triassic time contained monstrous fish-like reptiles of varied size, which, with strokes of paddles and tail, ranged the open sea seeking smaller forms to devour. Our knowledge of them dates back to the year 1901, when some of these spectacular fossils were first found in California. These fish-like reptiles, ichthyosaurs, were discovered in limestone in Shasta County on the west side of Pit River and Squaw Creek near Brock Moun-

tain. This limestone deposit furnished a large number of invertebrate forms, but only a few reptiles and fishes, so far as vertebrates are concerned. The rock, the age of which has been set as Middle Triassic by the geologist, yielded some remarkable specimens of these gigantic sea lizards, remains of which have been found in such widely separated places as Europe, Spitzbergen, western North America and possibly New Zealand. Furthermore, some of them are so widely different and peculiar to California that a whole new group, called the Thallatasauria, has been established by J. C. Merriam, based on specimens secured in Shasta County. All of these strange fish-lizards, some of which grew to be twenty feet long, had alligator-like snouts with well-developed teeth. Locomotion was evidently accomplished by means of four flippers or paddles and a shark-like tail, reversed in form. Their prey was apparently caught by a swift snap of the jaws. Most of them were residents of the high seas but some show characters which lend the possibility that they were shore dwellers.

Ichthyosaurs were much like dolphins in appearance, with no neck, the body heaviest in front and tapered to a slender tail. The front paddles, situated close behind the head, were larger than the rear ones. The naked skin covering was dark in color above and probably lighter beneath. Because they breathed air they could exist out of water, but judging by their structure they would be very clumsy. Most of them seem better equipped for life in the open sea, where they probably moved about in schools. So many specimens have been found in Europe that every museum has some on display. Furthermore, specimens have disclosed the fact that the young were born alive and that the food consisted largely of fish, squid and other sea life.

Limestone caves in Shasta County have yielded many

fossil bones. In Potter Creek Caves were found more than fifty species, at least half of which were of extinct forms. Not only were these cave fossil remains numerous but they were well preserved. They were apparently accumulated by falling into the cave or by washing in from the surface. Bones of several species of present-day mammals, such as the mountain lion and certain rodents, were secured together with remains of a fossil horse, a ground sloth, bison, camel, mastodon, elephant, lion, wolf, and, of special interest, a great bear and a goat-like animal known as Euceratherium. From another cave in Shasta County, the Samwel Cave, a different type of goat-like animal was taken but no remains of the bear.

Fossil horses, many of which have been found in the West, have long been used as the stock illustration to show progressive change and adaptation to environment. After filling many links in the chain of evidence, scientists now trace the ancestry of the modern horse from a small four-toed animal about the size of a domestic cat, through a three-toed form to the one-toed type of the present, with its rudimentary second and third toes represented by splint bones. The development has been toward speed. Likewise there is a change in the character of the teeth, indicating adaptation for the use of hard, innutritious grasses of dry plains, which need thorough mastication. Scientists are convinced that "horse, rhinoceros and tapir, three races widely different today, are derived through progressive changes from a common ancestral type."

Bird remains in the various cave deposits have totaled from twelve to twenty varieties. Condors were much in evidence, and several species of owls, which might be expected to be cave dwellers, left their record. The presence of ducks and geese and various quail and grouse, and the broken condition of the skeletons thereof, lead to the be-

lief that these caves were the abode of cats and other predatory animals that carried bird prey into the safe retreat to feast upon them, thus leaving the bony remains that paleontologists have found.

Rancho La Brea, Graveyard of Extinct Mammals

About nine miles out from central Los Angeles toward Santa Monica, one will find a small roofed structure with an interesting label to the effect that it commemorates the finding of the Rancho La Brea fossil beds. Going into the pit covered by this roof one may see numerous exposed bones in an asphalt matrix. This is possible because someone was thoughtful enough to erect this memorial in order that future generations might better understand the manner in which nature has successfully stored specimens of prehistoric animals.

Probably nowhere has Mother Earth furnished fossil animals and birds in such abundance, in such perfect form as in the asphalt of Rancho La Brea. Nor have there been found elsewhere materials allowing so nearly complete a picture of life on the North American Continent during a part of Pleistocene time, that period just previous to our own, when mammals became predominant. Thousands of splendidly preserved bones and many complete skeletons of over a hundred prehistoric species bear witness of other days in Southern California. And what animal life existed here probably did not differ greatly from that of most of the then land area of North America. The animal life of today appears insignificant compared with that of the olden days when such giants as mastodons, mammoths and ground sloths roamed the earth.

If we may depend upon written history, man's knowledge of these tar seepages goes back to the early days of exploration. The diary of Gaspar de Portolá during the California expedition of 1769-70 describes "pitch" springs.

Since the notation was made at a time when the party was in the vicinity of Rancho La Brea there is good reason for suspecting this to be the place referred to. Portolá's account apparently is the first written mention of the area.

A geological report of an early exploring expedition (Pacific Railway Reports, 1857) refers to "bituminous or mineral pitch" as arising from the ground in large quantities in the vicinity of Los Angeles. This may of course have referred to other seepages but the area nine miles west of the city has always had the more noticeable tar springs. Apparently William Denton was the first man to publish a description of the area and attempt to fix the age of the geological formation. In 1875, in the Proceedings of the Boston Society of Natural History, he describes Major Hancock's Brea Ranch and tells of the "almost inexhaustible" supply of asphalt covering sixty to eighty acres which was being mined for use in roofing, paving and combustion. At the time of his visit twenty-five Chinamen were employed by Major Hancock to do the mining, and the product brought twenty dollars a ton. He states that Major Hancock presented him with the tooth of a saber-toothed tiger secured at a depth of fifteen feet in the asphalt. He obtained also "teeth of a fossil horse, bones of the deer, a large bovine animal, the otter, seal, albatross, and other animals."

So fresh and well preserved were the great masses of bones found, in some instances sufficiently abundant to cause the mining of the asphalt to be unprofitable, that they were thought to be recent animals. The common sight of rabbits and birds being caught in the sticky seepages lent credence to the belief. Nor did the early account of the geologist, William Denton, stir paleontologists to delve deeper into these fossil beds, at least for many years, for there was no activity until Dr. J. C. Merriam made a visit to Rancho La Brea in December, 1905, at the instance

of Mr. W. W. Orcutt, of Los Angeles. Mr. Orcutt was the first to recognize the fossil remains there found as of the period preceding the present. Following this long lapse of time between Denton's discoveries and the year of the San Francisco earthquake came a real period of active exploration covering about ten years, which has greatly advanced the science of paleontology. Owing to the generosity of the owners, extensive collections were secured by the Los Angeles High School, Occidental College, and notably the Museum of History, Science and Art of Los Angeles, and the University of California. Tons upon tons of bones actually have been removed, more, in fact, than will soon be utilized by students. The writing of the last word on these notable collections will have to be left to another generation, so extensive is the material. Yet the past twenty years of excavation and research have revealed many interesting features of the animal life that figured in the western landscape of ages past, the record of which has been so long hermetically sealed and is now opened for our inspection.

Geologists explain that crude asphaltic oil from underlying shales has been forced to the surface through chimney-like cracks in the rock, forming pools. Exposure to the air has resulted in distillation, the residue being heavy viscous asphalt capable of entrapping both small and large animals.

The bones exhumed occur in deep narrow pits, representing the accumulation in various tar pools that remained distinct. Clay deposits separate these bone-filled chimneys. H. S. Swarth has given this vivid description of the manner of accumulation: "From these and other facts the conclusion has accordingly been reached that these deposits were not depressions, which during Pleistocene times were filled with tar and the accumulated mass of bones which are now found therein; but rather that there was

continual seepage on the top of the ground, and gradual building up of the deposit, together with the surrounding formation. In other words, that during a long period of years the entire surface of this whole general region was being slowly built up, and these tar pools, of varying sizes but never deep, were continually storing up bones, being covered with dust or sand and breaking out anew, but always about on a level with the surrounding plain. Although there may have been an occasional more rapid burial or filling at certain points, it is in this manner that the dense masses of asphalt surrounding bones now being unearthed are for the most part supposed to have been accumulated."

The finding of some water birds gave rise to the belief that water may have covered the tar pools, as does also the finding of leaf masses and water-worn fragments of wood, but, as ducks have sometimes been attracted and caught in oil sumps on moonlight nights when the sticky oil gives the appearance of a sheet of water, the explanation of the presence of water-fowl in the tar need not rely on the actual covering of the pools by water.

The first popular account of the discoveries of Rancho La Brea contained the following suggestive picture of the making of these fossil beds: "Here for centuries, evidently, the enormous ground sloth and other clumsily moving creatures of his kind came for water, only to be held relentlessly; herds of bison and horses were entombed, extinct forms with whose bones mingle those of the mammoth and the camel. To this helpless prey, snared in this bird lime bed, came the huge saber-tooth tiger and the monster wolf, the largest of the dog family. Trapped in their turn, they, too, fed the black maw of the asphalt pool and the death-trap baited itself anew."

These asphalt beds of Rancho La Brea probably hold the most extensive and best preserved fossils of more recent

mammals and birds that have yet been found. Sealed in the tar for ages, the bones of prehistoric animals are exhumed in perfect condition, and, as specimens, will survive practically any other type. In many instances, complete, or practically complete skeletons have been obtained, allowing knowledge of every bone.

The more unusual features of the Rancho La Brea fossils may be summed up in outline form as follows:

1. Manner of occurrence.
   a. Asphalt rather than rock.
   b. Chimney-like accumulations surrounded by soil, apparently old seepages containing great masses of bones, but scattered, making assembly difficult.
2. State of preservation.
   a. Nearly perfect. Change in color produced but structure of bone unchanged.
   b. Many skeletons practically complete.
   c. Splendid specimens of bird bones which, as a rule, owing to their fragile nature, are the rarest of fossil bones.
3. Abundance.
   a. Life of Pleistocene period revealed nowhere else in the world with such abundance and completeness.
   b. Saber-tooths and wolves averaged 20 per cubic yard in some instances; in one instance, 30 saber-tooth skulls and 50 wolf skulls were taken in less than 4 cubic yards.
   c. More than 2,000 saber-tooths and more than 3,000 specimens of the dire wolf have been exhumed.

4. Forms represented.
   a. Herbivorous animals (horses, bison, camels, elephants, ground sloths) few compared with carnivorous.
   b. Preponderance of predatory species; more than all other mammals combined. Largely of cat and dog families.
   c. Small mammals include gophers, mice, rabbits and squirrels.
   d. Few water birds: ducks, geese, pelicans.
   e. Birds of prey, incredibly abundant in species and individuals: eagles, hawks and condors.
   f. Only reptiles found: snake and small mud turtle.
   g. Some fossil plants.
   h. Insects found: largely beetles and centipedes.
5. Many old, young and crippled animals.
6. Method of entrapment:
   a. Accidental crossing of soft tar pools.
   b. Lure of water pools in association with tar springs.
   c. Lure of entangled animals which might serve as food.

Preceding man's rule of the earth, and after glacial invasions, we must picture great forests interspersed with open grass-covered plains, with some marsh and open water. We must picture the animal life as quite different from that which we have seen with our eyes, although a few bear similarity sufficient for us to name them quickly as elephants, rhinoceroses, bison, camels and horses; the plains with countless herds of the horses, the forests and marshes attracting great herds of bisons and camels. Closer views would show the elephants covered with long hair, the bison with different shaped horns, the horses much

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smaller and of many kinds. Clumsy, slow-moving beasts digging for roots, or seated on their haunches munching foliage off lower limbs of trees pulled down by their fore feet, we would have to name ground sloths. Ferocious saber-tooths with two walrus-like tusks, four inches in length, are to be seen stalking one of the sloths. To kill one of the armored sloths these tusks must sink deep and touch vital parts. Several large wolves are waiting to get in on the kill while a few slinking coyote-like animals are working the edges of a marsh for small animals and birds. A huge bear feasting on a young mastodon, elephant-like but abundantly covered with hair. Waterfowl are common on every pond, watched by eagles and hawks soaring above, and wild pigs root along the shores. Gathered about the carcass of a dead camel, and perched on nearby trees, is a swarm of great carrion feeding birds far exceeding in size the largest condors or buzzards.

Such a scene as I have pictured was typical of a period covering hundreds of thousands of years. Yet there were such marked changes of climate and variations of shore line and land elevations that it was a critical time so far as plant and animal life were concerned. Previous climates had been mild, but this was the "great ice age." At least three times a great ice sheet covered the larger part of North America. The Sierra Nevada, already a high mountain range with deep water-cut cañons, became clothed with ice and through the years great glaciers gouged the cañons deeper and straightened the walls, leaving Yosemite and Kings River cañons. There is evidence that twice, and probably three times, events of this kind took place in the Sierra. Animal life must have been driven southward periodically with the advance and retreat of the ice, for great areas were thus made uninhabitable for all vertebrate life. Such periods were interspersed perhaps with warm climates, and southern species, like the

horses, camels and elephants, migrated northward to feeding grounds uncovered by the retreating ice.

In recent years scientists are deserting the theory that an exceedingly cold climate during glacial times alone caused the extinction of many forms of animal life. There is evidence that climatic change during this period was due to heavy precipitation resulting in large stream flow and the accumulation of great snow fields. The climate might well have been in general mild rather than cold and the presence of ice fields the cause, not the result, of a cold climate. This new view in no way alters the apparent fact that this was a period of stress and that it directly or indirectly caused the extinction of many species of mammals.

Henry Fairfield Osborn suggests that the conditions causing extinction include diminished herds, enforced migrations, the possible overcrowding of certain southerly areas, changed conditions of feeding, disturbance in the period of mating and reproduction, new relations with various enemies, aridity, deforestation; in short, a host of indirect causes.

The more we view past climatic changes, the more we are led to speculate as to a return of glacial periods. In the Yosemite Museum, as the nature guide reveals the geological history of the incomparable valley by means of models and word pictures, someone is sure to ask: "Will there be another glacial period?" Who can say?

Outstanding in the asphalt beds is a preponderance of predatory forms, both mammals and birds. In the case of mammals more kinds of flesh-eating forms have been found than of all other forms combined. One small pit yielded thirteen individual saber-tooth, lion and wolf skeletons. Merriam[1] accounts for this preponderance on the basis of a selection which may be seen about tar

[1] *Merriam, John C., 1911, The fauna of Rancho La Brea, Part I. Memoirs Univ. of Calif.; I, pp. 199-213; 5 pls. 1 fig.*

pools even at the present time. "Whenever an animal of any kind is caught in the tar its struggles and cries naturally attract the attention of carnivorous mammals or birds in the immediate vicinity, and the trapped creature acts as a most efficient lure to bring these predaceous animals into the soft tar with it. It is not improbable that a single small bird or mammal struggling in the tar might be the means of entrapping several carnivores, which in turn would naturally serve to attract still others."

The explanation of the finding of many immature and crippled animals is the natural one of their inexperience and inability to cope with the sticky tar and escape entombment. Old animals, likewise, lacked the strength to make their escape.

The large four-inch tooth of the saber-toothed cat first brought attention to the fossil remains of Rancho La Brea. Since then much has been written about the saber-tooth and the average Californian is certain to be familiar with this extinct cat, if he is cognizant of any extinct mammal known to the state. To visitors and workers the abundance of specimens, and the completeness with which skeletons could be assembled, have made this great cat a favorite. Although often called tiger, its bones show no greater relationship to this modern animal than to other large cats like the lion or leopard. Of course no evidence of its real coloration is available. Because the California form is distinctive, its scientific cognomen is taken from the name of the State. Remains of somewhat similar animals have been found in Europe, Asia, and in the two Americas. The largest once lived on the Argentine plains.

In the days when giant ground sloths browsed on the trees, the animal apparently developed to prey upon them was the saber-tooth. With a lower jaw so hinged that it could be dropped to the fore neck, and with heavy muscles,

the saber-like teeth could be sunk deep into the flesh of the prey and reach vital parts.

Furthermore, these teeth were sufficiently sharp-edged to cut as well as stab. Ability thus to stab with forward and down-pointing tusks demanded good foothold and consequently the claws were well developed, much better in fact than those of the living African lion. That these giant killers became handicapped by broken tusks as a result of some encounter is attested by maimed specimens found.

In bony structure, in musculature, in many different ways the saber-toothed tiger was well adapted for preying successfully upon herbivores much superior in size, and even for conquering the ground sloth, protected as it was with an armor of bone.

Other remains of much less abundance are most like the African lion, with a skull fully eighteen inches in length. We may picture this animal larger than any living member of the cat family and almost as large as a Kodiak bear. The finding of both large and small skulls seems to indicate a difference in the size of the two sexes as is the case with the present day African lion. Smaller cats like the mountain lion and wild cat also left their bony record in the asphalt.

As allies of the saber-tooth, in pulling down and devouring the giant browsing animals of those times, were the wild dogs. Some, including a giant wolf, are nearly as distinctive a feature of La Brea as the cat with its over developed saber-like teeth. More than 3,000 skulls of this dire wolf have been recovered, making half the total of specimens representing the dog family. It must have been much larger than any living species and combined a large head with light limbs, indicating ability as a bone crusher but inability as a runner. It could undoubtedly cope with the large browsing animals, especially if it

traveled in packs as is surmised. Fossil remains of a closely similar wolf have been found in the Livermore Valley and in Tulare County. Three other wolves were contemporaneous, one very like the timber wolf.

Coyote-like dogs differ little from present day forms either in structure or probable habit. The Orcutt coyote appears to be the direct ancestor of the living form. Its lesser abundance may be accounted for by the "nature of the lure attracting wolves, mode of hunting, and possible difference in intelligent recognition of the danger encountered." Less well-equipped for a struggle with an armored sloth or massive elephant, the coyote perhaps had less temptation; or, perhaps by superior intelligence, escaped the fate of its larger cousins.

In all, five wild dogs and a gray fox very similar to the one still resident in California, and known by only a few specimens, make the assemblage of canid forms represented in the Rancho La Brea deposits.

Enormous bears, larger than either the grizzly or the brown bear, found a place in the fauna of Pleistocene time. Because their remains have often been found in caverns, they are termed cave bears. They were evidently fitted, like several animals already described, for attacking young mastodons and other contemporaneous animals. Other remains somewhat similar to our black bear give evidence of varieties more nearly like present day forms.

Many years ago footprints were discovered in the rocky floor of the prison yard at the Nevada State Penitentiary at Carson City, Nevada. All sorts of conjectures as to their origin were immediately made, even to a widely heralded story in the newspapers that they represented the tracks of primeval man. As usual, though far from the truth, the more spectacular the explanation, the better the newspapers liked it and utilized it. It is now the consensus of opinion that these tracks, and still better ones found in a

nearby tunnel, were made by a large type of ground sloth which once roamed most of South America and at least the southwestern part of North America. Lending support to this theory is tangible evidence unearthed nearby, of fragments of a skull and bones of a ground sloth.

The latest expert word is by Dr. Chester Stock: "They represent the impressions of the hind feet that have been superimposed on and have largely obliterated the imprints of the front feet. The best preserved tracks show a raised border where the soft mud bulged upward along the side of the foot as pressure was exerted downward when the animal walked across the surface of the ground." Students have further read from the rock the story of a battle between these giant sloths, and even venture a guess as to the prevailing direction of the wind when the tracks were made. The imprints of opposing feet show that they were dug into the mud in attack and resistance. Evidence that one sloth sat on its haunches is recorded there also and even marks of the coarse hair with which the animal was covered. One face of the footprints is covered with sand as if a strong southeast wind had blown it onto the squeezed-up mud.

These "footprints in the sands of time," or mud of time, now hardened to rock, are of proper size and shape to have been made by an armored ground sloth like one of those represented in Rancho La Brea, where three different kinds have been discovered. A smaller kind, known by the name of *Nothrotherium*, was apparently less heavy but had large claws, comparatively long limbs, and lacked the bony elements in the skin. Like the larger *Mylodon* it carried a heavy coat of hair. Its range was probably more restricted to a jungle or at least a forested type of country and it may not have lived very near the tar springs which have given up its bones. A guess at its food would include

herbage and foliage within reach at the base of a tree. All of the ground sloths were vegetarians.

These great animals that have left a record of their existence in nine places already found in California, and in three places in neighboring states, were, judging by their skeletons, smaller than the mastodon, but were ponderous, slow-moving beasts. The front legs were probably used in food-getting and as a means of defense. The lack of biting teeth at the front of the mouth allocates these animals to the larger group of edentates, which group includes the ant-eaters. Strong prehensile lips allowed the ground sloth to pull off foliage and tear roots from the ground even though lacking teeth at the front of the mouth. Thick skin imbedded with pebble-like bones, some as large as an inch in diameter, acted as an armor against the saber-tooth, perhaps its greatest enemy, and other predators. Long, coarse hair probably covered the entire body. Standing five feet high and nearly as wide, these great animals may have roamed the open plains in small herds, browsing on grasses, shrubbery, berries, roots and herbs, perhaps rearing on their haunches better to secure the foliage of low-hanging limbs.

I well remember in my college days the report that bones of a prehistoric animal had been found in Puddingstone Cañon near San Dimas, in eastern Los Angeles County. An expedition from the biology department of Pomona College was organized and soon there reposed in the museum tusks, teeth and leg bones of a mastodon. Mastodon remains are so wide-spread in North America that most persons can recall instances of similar finds. In fact, so many thousands of teeth and jaws and, in some instances, nearly complete skeletons have been found that this relative of the elephant is one of the best known of extinct mammals.

The mastodon was of massive proportions, but not so large as the mammoth; one form stood ten feet high at the shoulders. It was more stockily built, with shorter legs than living species of elephants. The upper tusks of the American mastodon, for some species had four rather than two, often seven to ten feet in length, curved upwards and inwards like those of the present day elephants, and were probably used to uproot trees and plants as well as for offense and defense. In other forms the tusks were shorter and curved upwards. The teeth, quite different from those of elephants, lead us to believe that the mastodon was a forest-dwelling animal and browsed largely on leaves and twigs of trees and shrubs. The proboscis was utilized in conveying food to the mouth.

Since many specimens have been taken from swamps along the Hudson River and elsewhere these animals must have congregated in swampy areas during cold weather or were attracted to such places for water or food. The ditching and draining of marshes have disclosed much of the material found in museums.

The teeth have cone-like cusps in rows, covered with enamel, and have long roots, whereas those of typical elephants possess narrow close-set plates, leaving a ridged surface, and have short roots. The peculiar method of renewing the worn teeth holds for this whole group of animals. A new molar growing behind the one in use slowly forces it forward where it is worn off. Thus several teeth may be worn out and discarded during the life of a proboscidean. Mastodons had a thick skin well covered with an outer coat of hair and an under coat of wool. In the one instance where the skin has been discovered the hair was described as "coarse, long and brown."

The first mastodon remains, found in California, were discovered during pioneer mining operations in the Sierra. Additional specimens have been taken in many places in

California, and even as far north as British Columbia and Alaska. Not only was it widely distributed in North America but it was evidently very abundant during glacial times, perhaps ranging in herds as large as those of the bison. With the reduction and disappearance of extensive forests during the post-glacial times, mastodons disappeared. Exactly when the last mastodon left his bones to decay in some swamp or secluded forest area is not known, but there are those who believe that some survived long enough to be contemporaneous with man. At any rate, bones of the mastodon have been found in close association with charcoal and pottery and some specimens found have appeared to be so recently buried as to lend credence to the idea. Even with this evidence, convincing proof is still lacking that man in North America ever saw live mastodons.

From the asphalt of La Brea have come enough bones to provide a mounted skeleton of the mastodon at the Museum of History, Science and Art in Los Angeles, as well as skulls of younger animals showing replacement of teeth.

Of greater proportion was the mammoth. However, the name is of Russian origin and does not describe its size. The original name given by the discoverer of bones in 1696 is to be translated as "ground dweller" because it was then believed to be a gigantic mole dwelling below the ground. The larger mammoths which ranged the Southwest probably reached the height of thirteen feet. The tusks were sometimes eight inches in diameter, from ten to fifteen feet in length, and often weighed more than two hundred pounds each. Only strong muscles could have supported a head with such unwieldy appendages.

Siberia has furnished cold storage specimens so nearly perfect that external characters are well known. The finding of a specimen in 1799 imbedded in ice, where it had

reposed from 10,000 to 50,000 years, the selling of the tusks for ivory, the destruction of the carcass by dogs and wolves, and the final recovery of the remains by a scientist, is now an old story. But it was this specimen that gave dependable evidence of the external appearance of the mammoth. The covering of long coarse hair and wool undoubtedly enabled this animal to withstand the intense cold of northern lands and glacial epochs. In recent years several fine specimens have been found in Alaska. One of them actually furnished grease for boats of the natives and another furnished both flesh and quantities of hair and wool. Again in 1900 a well preserved mammoth was discovered in Siberia and although through misfortune some of the animal was, like the first, lost by attacks of wolves and by decay, enough was saved to allow restoration and the mounting of it in the St. Petersburg Museum. Even recent visitors to Russia report seeing this mammoth, with its hair, in the Museum of the Academy of Sciences. Alongside is a display of the stomach contents. Its position and its broken bones indicate that this animal was probably killed by the caving away of an undercut river-bank.

Thus has nature's refrigeration preserved a record that helps us picture one of the giants of the past and one with which early man may have been acquainted. Not only have the bones of the mammoth been associated with flint weapons but pictures giving a fair portrayal of the mammoth have been found. Notable are those found on the walls of caves in southern France and Spain.

The word camel brings to the mind a picture of a caravan on an Arabian desert, or of animals in a circus menagerie. To only a few does it bring thought of scenes on the American continent 50,000 years ago. Yet fossils attest that several kinds of camels, some like the well-known thirst-resisting "ship of the desert," and some like the

llama of South America, were in our country and certainly in our own state in ground-sloth days of long ago. Roaming the plains in great herds, as did later the bison, the camel must have been one of the most abundant of mammals. More remains and more complete specimens of camels have been taken from Rancho La Brea than from anywhere else in North America.

Seven fossil species of North American bison are known. They ranged from Florida to Alaska. One species, the ancient bison, left evidence of its one time abundance in the Southwest in the asphalt (it was first described from remains from Kentucky). Larger than the living bison, its horns take a different position, being at right angles to the long axis of the skull.

A sizable horse, typical of the great herds of horses that grazed the plains of western North America previous to the last period of glaciation, a white-tailed deer, a tapir, a peccary or wild pig, and a relative of our prong-horned antelope, complete the list of herbivores represented in the asphalt.

Of smaller mammals, such as rodents, there are few that differ markedly from living forms. In the order of abundance are gophers, kangaroo rats, pocket mice and cottontail rabbits. These animals, so nearly like our own, bring evidence that climatic conditions at the time these fossilized specimens lived were not greatly different from those of our day.

Bird bones, being hollow and fragile, are not often associated with fossil remains. Yet in California, fossil bird bones have been found in a number of localities. Specimens are abundant in both individuals and species. From Rancho La Brea have been taken at least 150,000 specimens. Nowhere else in North America has such an opportunity been afforded for studying the bird life of the

past, especially birds of the predatory type, as in California.

Birds form a very conspicuous part of the trapped animal life revealed in the tar pits, most of them being either scavengers or predators. In fact, more than half the total remains are of birds of meat-eating habit. Of vulture-like birds, there have been identified three large condor-like birds and two smaller vultures, more nearly like our turkey vulture, two old world vultures, and one caracara, similar to the still living Mexican species.

To this assemblage must be added the still larger *Teratornis*, a great condor-like bird whose skull and wing bones proclaim it the largest bird of flight, past or present, yet discovered. The narrow eagle-like bill indicates a flesh eater and a bird of powerful build. Since specimens have been found near the surface there is a possibility that some of these birds may have been known to primitive man in this region. So distinctive is this bird that Dr. L. H. Miller, who first described it, has placed it in a separate family. The largest present-day flying land bird is the condor, there being little difference in size between the two varieties, the Andean and the Californian.

Hawk-like birds identified include six different eagles (as compared with our present two in California), three buzzard hawks, three falcons, a marsh hawk and a white-tailed kite. At least six owls were present in those far distant times to carry on the work at night which this array of eagles and hawks accomplished in the day time. However, remains are not numerous, perhaps because of rapid entombment of the small mammals upon which they preyed, or because of a hardening of the tar at night when night prowlers were abroad.

The great traps so effectively set by nature first caught those animals which came to drink or were otherwise tempted, or accidentally stepped into the asphalt. What

a meal for saber-tooths, wolves and lions a great ground sloth would make! Such an animal caught in the sticky asphalt of course at first made a lure for all predatory species of bird or mammal, and then for the scavengers. Not even the bony tough skin of a ground sloth, part of whose body would lie exposed above the tar, would protect the dead animal from having its bones cleaned by such great birds as *Teratornis*, which, in the bird world, matched the giant mammoth of the period. The presence of so many birds of predatory or scavenging habit clearly points to the unique circumstances surrounding their entrapment.

Other Tar Pits

Tar pits at McKittrick in Kern County, more recently excavated, have revealed forty-three different species of birds. In contrast to conditions at Rancho La Brea the remains were largely of water birds. Ducks and shore birds are numerous and herons, cranes and storks are represented. The notable lack of gulls and diving birds is difficult to explain. The type of bird life indicated by the two-thirds preponderance of water birds, and the presence of mud-gathering swallows, give us reason to picture an open country with large expanses of shallow water, a typical resort of water-fowl, together with mud flats attractive to shore-birds. Only five hawk-like birds and three vultures have been found in this locality as compared with the more than a dozen hawks and nine vultures credited to Rancho La Brea.

Of wading birds there were storks, cranes and herons. The nearest relatives of some of the storks are now found in Asia and Africa.

In spring of 1927 a new tar pit yielding valuable fossils was discovered on the Higgins Ranch at Carpenteria, Santa Barbara County. The pit disclosed several of the same birds and mammals found at Rancho La Brea and at Mc-

Kittrick; the giant condor, *Teratornis*, and other vultures, turkeys, a prehistoric horse and a wolf. No immediate evidence of the presence of the saber-tooth, however, was encountered.

The chief distinction of this pit is the wealth of botanical material. Coniferous trees predominate. Splendidly preserved cones, twigs, leaves and even flowers were found in numbers. Cones of the Monterey pine and Gowan cypress prove that these trees once had a much wider distribution. Manzanita and California lilac were associated forms. A different, certainly a more humid climate, must have existed here during Pleistocene times. This further evidence as to the tree growth in prehistoric times has led botanists to think that the tree unearthed at Rancho La Brea is more likely to be a distinct type of cypress and one associated with a more arid situation. The Monterey district at the present time contains an assemblage of plants very similar to that found at Carpenteria. Specimens even showed mistletoe, threads of fungus, and borings and remains of beetles. Minutest details of structure and appearance of leaves and flowers were discernible in many forms.

The trees of Pleistocene time were not far different from those of the present as judged by specimens taken from Rancho La Brea. Acorns attest oaks of several species and cones and seeds indicate junipers and cypresses. Other specimens point to the presence of manzanita.

Although no evidence is forthcoming from the asphalt, the Sequoia was probably the predominant tree during preglacial times. The whole western slope of the Sierra and probably most of the valleys were forested with Sequoia.

Authentic prehistoric human remains have not yet been found in California. A skull from Stone Man Cave is heavily coated with stalagmite so that its age is difficult to ascertain. Likewise a skull from the asphalt has been difficult to place. Both are considered recent. Shell

mounds on San Francisco Bay have also yielded human skeletal remains in quantity but apparently of recent origin. Associated with the skulls are great masses of bones of mammals and birds, evidently the refuse of the Indians whose garbage supposedly built up the mounds. Bones of the sea otter are numerous, as are those of ducks, geese and pelicans.

The Oldest Fossils

A more recently read chapter on life development of the past, and a significant one in the history of life on the western side of the continent, is that disclosed in fossil deposits discovered on the Mojave Desert and reported by J. C. Merriam. Exposed rocky formations of volcanic origin, mostly ash, near Barstow and Ricardo, have yielded three forms previously unknown, or imperfectly known, from the Great Basin, and constitute the largest and most important record of Pliocene times yet discovered in North America. Remains are widely scattered over the desert and complete skeletons of animals are rarely found. Dependence on fragmentary specimens, a broken bone or an isolated tooth, has been necessary. In age all but one set of the formations precede the notable Rancho La Brea findings.

Among the Mojave animals dating farthest back are two rare small horses, which, like the earliest forms of the horse group, have teeth which show them to be of the browsing rather than the grazing type. Two other types about the size of a colt of the modern horse and with longer teeth, showing a grazing habit, have also been found. The latter had one large middle toe and two small, scarcely functional side toes.

A remarkably large number of other animals known only by their fossil remains must have lived at the same time that these small horses ranged the western plains, for the

collections made include bones of both large and small camels, of deer, antelope and wild pig. Of dog-like animals there was one similar to a fox, and several other larger ones with massive bone-crushing jaws. The cat family is represented by a saber-toothed tiger and seven other forms. Two kinds of rhinoceroses, animals now restricted to Africa, add interest to this assemblage.

These old fossils attest an open country with abundant grass and herbage and a climate quite different from that of the present day. Shells prove that water holes and streams were present in that distant time. And bringing the succession practically up to the present are specimens of desert reptiles like the tortoise and rattlesnake, several flesh-eating animals like the mountain lion and skunk, and larger mammals like the prong-horned antelope and mountain sheep.

As in other instances a study of such a remarkable series of relics of the past leads inevitably to the conclusion that animal life has existed on the earth for a very long time, so long that a computation in years is wholly inadequate, and that life has changed progressively toward types now in existence. The world scheme must be a growth from simple to more complex forms of life. Certainly this is the story told to man by the secrets now disclosed in the formations of the Mojave Desert.

Rocks now exposed, laid down beneath the Miocene sea, more than a million years ago, contain numerous remains of fishes, mostly quite different from living forms and indicating life in a sheltered bay. The deposits in which the fossils are found are largely shaley rocks, light in weight, which under the microscope are seen to be composed of the shells of minute organisms called diatoms. Judging by the deposits the region south of the Tehachapi Mountains was composed of sheltered islands in an arid region with a mild climate. In quiet bays

the diatoms sank to the bottom and formed the diatomaceous shale without an admixture of other sediments.

In the Lompoc Valley of northern Santa Barbara County are such large deposits of this kind that the rock, properly termed celite, is quarried and used for insulating walls of buildings. On the surface of these bricks the imprints of fossil fishes are often found, especially remains of flounders. One small flounder shows characters which indicate it to be the most primitive one known.

The group of flat fishes to which the flounders and soles belong have adapted themselves to life on a sandy bottom. Although they swim on their sides, a unique twist of the head and a transposition of the eye orients the fish for life on the bottom. These fishes start life much like others, swimming upright, and with eyes on each side of the head. With development the left eye (in northern forms, the opposite usually in tropical forms) migrates to a position on the right side and the fish begins swimming with its right side uppermost. The upper side becomes darker in coloration and the fish resembles the flat fish as we know it. In the development of one of these fishes we probably see pictured the slow modifications and tendencies which have attended the evolution of the whole race.

Rocks of similar age (Miocene) in many places in California have furnished large collections of fossil shark's teeth. The teeth are the main hard structures preserved in the rock, for the cartilaginous skeleton of a shark does not leave a record as does the bony skeleton of a fish. Apparently sharks of predatory habits were exceedingly numerous in ancient seas. In the waters covering some parts of North America they were of great size but thus far Californian specimens discovered are of smaller size, little larger perhaps than so-called man-eating sharks of the present. Within the past few years additional collections of teeth have been obtained in cañons near San Diego.

In these diatomaceous deposits, in which so many specimens of fossil fishes have been found, were also taken ten complete specimens of birds. The bones are so carbonized that they are brushed out and the remaining impressions used for making casts. Six different kinds of birds are represented in the ten specimens, all but one being fish eaters, lending support to the view that the accumulation of the beds took place in a sheltered bay of the sea. Shearwaters are of the type that would go into such a bay to feed. Remains of seals and sea cows attest the same situation.

New beds of fossils are nearly always first reported to scientists by laymen. The discovery of an unusual tooth or tusk or bone catches the attention of the finder and when this is reported to some paleontologist he begins excavations which add a wealth of knowledge. Within the past few years several finds in the San Francisco Bay region have brought proof of land submergence. Dredging operations in Suisun Bay near Crockett brought to light remains of Pleistocene horses and mastodons secured at a depth of 100 feet. During the excavation of the Oakland-Alameda estuary tube bones of an elephant, a ground sloth, a bison and a camel were found by workmen. Teeth of a fossil horse were recently brought to light near Rio Vista on the lower Sacramento River. Thus it may be seen that it does not necessarily mean a costly exploring expedition to unearth valuable evidence of former life. These contributions, the more recent of many such, have helped to picture former conditions in the bay region and to link this area with the better known ones of Southern California. More and more is it evident with new finds that Pleistocene life is remarkably well represented in California formations.

Why are so many animals extinct? What is the cause of their extinction? Beyond hazarding a few guesses based

on the knowledge of great changes of climate which involve food supply and proper cover, we normally fall back on the generalization "the law of progress." Through time there appears to be a continual supplanting by forms better adapted to existing conditions.

This study of the evidences of the former life of California is an aid to proper comprehension of the present, and the world we live in. The sequence of animal forms through time indicates orderly progression, and rise and wane of various species, culminating in life as we know it. Progressively, fishes, amphibians, reptiles and mammals have been predominant forms on this earth of ours. We live in the waning days of the Age of Mammals.

Present day forms will live comparatively short existences because of interference by man. Many species are threatened with extinction and pictures and printed words are the only things that attest the former existence of others. The pioneer took what he needed as he "lived off the land," but soon the incentive of the dollar led the hide hunter to unparalleled slaughter. Coincident with the hide hunter's activities, and continuing to the present without cessation, has been the fur trade, the ravages of which threaten so many fine mammals. Fabulous prices are paid for furs. Trappers traverse the most out-of-the-way places. Some laws regulating trapping there are, but the near extinction of some of California's most valuable fur bearers, sea otter, fisher, marten and wolverine, is conceded by the trappers themselves. The whale is a waning species because of the market for oil and bone, and the elephant seal is no longer a resource for the same reason. Never-ending warfare on predatory species has eliminated from the State the grizzly bear and wolf, and if wholesale poison campaigns are continued other species will be added. An over amount of hunting and reduced breeding grounds have resulted in a permanent closed season on

every large game animal in California, with the exception of the deer and black bear. No hunting of elk, antelope or mountain sheep has been allowed in California for more than twenty years.

What has taken place in California holds for North America, for Europe, for Asia, for Africa. Plot the former and present distribution of elephants, of rhinoceroses, and one notes the limited area left to these species. Museums of the world are making a last minute rush for specimens. During our lifetime we are actually witnessing the closing of the age of mammals.[1] When nature plays a sole hand we may be content, but when the end is hastened by man's spoliation we may well worry about the results of our short-sightedness and wasteful methods. A study such as this should lead everyone to join the army of defense and constitute himself a conservationist.

[1] *For further discussion of this subject, see Osborn, H. F., and Anthony, H. E., 1922, "Can We Save the Mammals?" Natural History, 22, pp. 389-405. A good bibliography is appended.*

Chapter III

CHAPTER III

Valleys Fair and Productive

The country where God's golden sunlight pours.—Harry T. Fee.

THREE DISTINCTIVE types of valleys are found in California; each possesses charm of its own. There are those in the coastal region, well hemmed in on every side by rolling hills; there is the great central valley, as flat as a dancing-floor and as large as the State of New York; and there are many partly enclosed, mesa-typed, sparsely-grown valleys of the coastal slope of Southern California which may be classified along with those of the desert.

Geologically the great central valleys—the San Joaquin and the Sacramento, joined at the junction of their rivers and frequently mentioned together as the Great Valley—are a filled-in sea bottom. The soil is wholly sedimentary in origin, being washed from the hills into the valleys by numerous streams. In some places hard-pan is found from two to four feet beneath the surface. Where it is not too near the surface most crops can be grown; however, it has been found profitable in the planting of orchard trees to blast a hole through the hard-pan so that roots may reach the loose layers of sand, gravel, silt and clay which lie beneath.

Irrigation projects have been the means of bringing about extensive agricultural developments. The alluvial fans and the foothill areas are well adapted to deciduous and citrus fruits, grapes and olives. Field crops occupy regions where less favorable soil conditions are present.

Nowhere has a greater transformation taken place than in the Great Valley. After the mining days the gold-seekers tried their hand at ranching. A little water diverted from a nearby stream made their acres productive. Now we find all of the best land cultivated. Great canals bring abundant water from storage reservoirs in the mountains. Grain fields have given way to fruit orchards and vineyards. Various districts specialize: Porterville in citrus fruits; Fresno in raisin grapes; delta region in potatoes and asparagus; Placer in deciduous fruits, and Butte in rice.

In the lowlands great areas have been reclaimed. The roads lead along the top of levees; that field of barley over there produces sixty bushels to the acre! The peat lands that have been reclaimed furnish the richest soil in the state. A distant view from a hilltop shows the familiar checkered effect produced by the square or rectangular land holdings. A clump of trees surrounds the farm house and the nearby highway has its row of poplars. Driving along the roads one finds oneself hemmed in on each side with barbed wire, though the fields stretch away in endless succession. There is barbed-wire fencing enough in this one great valley to fence in the whole United States. In springtime the fruit orchards in bloom make an indelible picture. Yet with all of this artificiality, with all this emphasis on productiveness, native life is there, as will be seen in the following pages.

The pioneer saw endless brush land when he entered a valley in Southern California through a gap between low hills. The sea of brush stretched away to the encircling

hills where the white specks marked the hives of bees of the apiarist. The keeper of bees could wrest a living with small equipment and little water. Through the years wells were dug, water tunnels driven, and the much-needed irrigation water was secured. As a result brush lands were turned into orange orchards and these now give way in places to suburban homes. Though native flora is largely gone, a semi-tropical one has been introduced which saves those ready to study it the trouble of traveling to foreign countries. Some bird and animal life has adapted itself to the new conditions; mocking birds find a home in orange groves where once they frequented the arroyos, and bats find their insect food about the street lamps where once they skimmed the brush land. The environs of the valleys still hold some of their pristine glory of original life.

In attempting description of the flower-grown fields of the valleys, I am reminded of a few lines which appeared in the *Sunset Magazine* under the authorship of Ida H. Johnson and Josephine M. Culbertson:

> "Whose calendar of perfect days was kept
> By daily blossoming of some new flower.
> The fields, whose carpets now were silken white,
> Next week were orange velvet, next sea-blue."

Flowers appear in great profusion: mustard, lupine, orthocarpus or owl's clover. These often furnish a massed effect in color. One of the first is the blue brodiaea sometimes called onion lily or wild hyacinth. A close head of blue lily-like flowers tops a smooth stem a foot or more in height. This flower is much gathered for house decoration and is prized because of its lasting qualities. The bulbs were used by the Indians for food. A golden yellow brodiaea is also common.

Buttercups furnish a shiny yellow color. Cream cups help to modify the strong orange color of the California poppy. Whole fields are turned yellowish brown by

woolly breeches or "fiddle necks." This plant is one of the commonest weeds of the valleys and is hated by the haymaker, who dubs it "fire-weed" because the dried hairs are irritating to the membranes of the nose and throat when dry hay is being moved. The ground is often whitened by the low-growing pure white flower known as popcorn flower. Seldom is the plant more than six inches in height. A small yellow daisy known as sunshine is responsible for a yellow carpet. Red maids are usually the first flowers to bloom in the spring, often showing before the grass is three or four inches high. Among the taller perennials is the familiar sunflower, hated weed pest of the rancher, adding color to a roadside with its large much-branched stalk, and numerous flowers.

Weeds are defined as "plants out of place." Until man found them troublesome, they were just plants; after tormenting the rancher, they are branded as weeds. Many of the most troublesome weeds are not native to the State of California; many have come from Europe. Some that give trouble were brought in as forage plants, as for instance, Johnson grass. It is estimated that three new weeds arrive in California each year, one of which becomes noxious. Usually they compete easily with plant crops and make places for themselves through peculiar advantages in seeding habits. Oftentimes the seeds survive though they wait several years for a chance to germinate. Furthermore, an abundance is produced. A native tumbleweed will produce six million seeds, a yarrow five hundred and seventy-eight thousand, and a black mustard one hundred and forty-three thousand.

One native California weed, of the compositae or sunflower family, blooms late in the fall. Tarweeds, for there are some thirty or forty different kinds, grow abundantly along every roadside. The sticky stems furnish a secretion having the smell of tar, hence the name. Bees

feed on the blossoms, but the sticky stem seems to afford a protection from ants.

Spring in the valleys brings memories of the song of the western meadow-lark coming from fence posts and grass-grown fields. No song bird is more typical of open fields, nor is there one of this section that holds the hearer more enthralled. Coloration is also attractive, for, though the mottled back blends with the surroundings, the bright yellow breast with a black collar, and the white outer tail feathers, which flash as the bird spasmodically spreads his tail, quickly catch the eye.

This is one of the birds that bear names distinctly misleading to the beginning bird student, for it does not belong to the lark family but to the blackbird-oriole family. Perhaps the fact that the bird is a beautiful singer and occasionally gives its song in mid-air, brought to mind the skylark of Europe. The name "western" has real meaning in this instance, for the eastern meadowlark differs not only in size but in its ability in song. Many a traveler, while on a westward transcontinental trip, has noted the distinctive change in tone quality and singing ability of meadowlarks. On reaching Kansas the more varied song of the western meadowlark is first noted. The meadowlark nests on the ground, in a depression lined with grass and hooded over.

With the planting of alfalfa and grain fields the meadowlark apparently is finding increased range, and grain growers have complained that this bird destroys newly sprouting grain. Investigation showed that the meadowlark does sometimes pull the sprouting kernel from the ground as a sweet morsel. However, when the stomachs of many birds were analyzed, it was discovered that the meadowlark turns its attention to grain during insect scarcity in midwinter. The rest of the year the bird gathers in quantity, cutworms, caterpillars, grasshoppers, weevils

and beetles which most annoy the owner of grain and alfalfa fields.

About every clump of valley oaks, one may expect to hear a series of bird calls resembling the syllables, "Jacob, Jacob." This is the call of the California acorn-storing woodpecker. The bird is conspicuous as he clings to a telegraph pole for the crown of his head is bright red and there is a white rump patch, otherwise the bird is black. In flight this woodpecker also catches the eye because of the white patches on each wing and a black belt across the breast. The California woodpecker's distribution is coincident with its ability to secure acorns as food.

More than any other woodpecker this bird has learned how to store a winter food supply. Pecking holes in the bark of trees or into the wood of some dead tree, it hammers acorns in, butt out, and then returns to the store during the winter shortage of food. Sometimes a tree is honeycombed with holes as high as sixty to the square foot. Sometimes a building is utilized. If a bird finds it necessary to increase the size of the hole before the acorn will fit, it drops the nut to the ground, enlarges the hole and retrieves the acorn. The acorns are made to fit so snugly that few are stolen by squirrels. Nature fakers have started the story that the bird makes his own worm factory, indicating that the bird knows that worms will develop in the acorn and that this insect food is its real quest. Since the stomach of birds examined contain quantities of acorns, this position is untenable. Doubtless the wormy acorns are greatly enjoyed, but certainly the wormy ones are not eaten to the total exclusion of sound ones. Almonds and kernels of corn are stored on occasion. There has been much speculation as to how the California woodpecker developed this habit and what actual benefit it derives therefrom. Some are inclined to think it a play instinct.

All agree that there is much waste energy; development of the habit falls far short of perfection.

The California woodpecker has remarkable communal habits. With most birds, parents during the nesting period are antagonistic to all other birds, even those of their own kind. There is much evidence to show that this woodpecker welcomes the company of its own kind even to the extent of letting several adults help in feeding the young. Whether they are other parents or bachelor males is yet to be determined.

One of the most beautiful birds, and certainly the most distinctive of the Great Valley, is the yellow-billed magpie. Its black and white "pied" coloration, and its extremely long tail, make identification easy. Though all the magpies found in the rest of North America have black colored bills, there was somehow developed in California a strain with a yellow bill. This bird has never been found outside of this state. This bird's range appears to be diminishing, for it is no longer found in Ventura County, though farther north in San Luis Obispo County it is locally common. Its range is separated from that of the black-billed magpie by the Cascade-Sierra Nevada Range. As one drives along the highway in the great central valleys, one may often see a yellow-billed magpie perched on a fence post or making off across a field with measured wing beat and trailing tail. When a nesting place is found in a grove of oaks, one is astounded at the large, globular nest which this bird utilizes in rearing its young.

Two mammals are typical of the open stretches, the jack-rabbit and the ground squirrel. The former bounds away, clearing the low vegetation as it runs; the other scurries rapidly over the ground and after stopping for an instant at the mouth of a burrow disappears within.

The California ground squirrel is considered a severe pest

in farming districts as it harvests for its own use the grain crop and takes its share of nuts. Having also been shown to be a carrier of bubonic plague, it is doubly under the ban and the campaigns against it are continual.

Long ago it was discovered that there was some relation between the dreaded "black plague" in India and rats. More recently this relationship has been made clear by finding that the fleas which the rat harbors are carriers of the causative germ. Early outbreaks of the disease in California were traced to the ground squirrel and squirrels infected with the disease were found. Supposedly the escape of rats from ships in California ports spread the disease among native rodents through the medium of fleas. As a health measure the government has waged continual warfare against the ground squirrel. Though kept under control, the animal is so prolific that it soon repopulates an area that has been poisoned.

Because of its economic importance the life history of this animal is well known, probably better known than that of other rodents. Ground squirrels usually live in colonies, their burrows often being connected for a considerable distance. Food in the shape of grain, seeds, and fruit is gathered at a distance from the burrow and stored for the winter season. After running within a safe distance of cover, the squirrel sits upright to watch an intruder, ready to dash down the hole at an instant's warning. Through much use, trails are made as avenues of travel to and from the burrow.

Along with a few others I am willing to defend the ground squirrel against such aspersions as, "no earthly good," and "every one should be exterminated." Burrowing rodents are the original cultivators and aerators of the soil. The fresh earth mounds grow the highest and rankest herbage. Moisture and air are carried deep into the soil by means of the burrows.

The pocket gopher eats the roots of plants and trees and constitutes another rodent pest. The earth mounds are familiar though the animal is seldom seen. Ground squirrels and gophers are easily distinguished by their general appearance, size, habits and burrows. The pocket gopher has very short ears, small eyes, short tail, and cheek-pouches which open externally; it is relatively small (six to ten inches), largely nocturnal, and lives almost entirely in its burrow. The ground squirrel has relatively large ears and eyes, longer tail, and the cheek-pouches do not open externally; most ground squirrels are larger in size, diurnal, and forage for food above ground. The burrow of the pocket gopher can be distinguished by a mound of earth surrounding the entrance, and by the fact that the opening is nearly always kept plugged full of earth. The burrow of the ground squirrel on the other hand is usually open, with the excavated earth thrown out on one side of the entrance only. One or more runways lead away from the burrow.

The jack rabbit furnished easily obtained meat for the pioneer and the animal is still shipped in quantity to market. Yet because of depredations on crops it is black-listed by law rather than protected as a game species. The smaller cottontail and brush rabbits have the status of game. A newly planted orchard where jack rabbits are abundant soon shows evidence of their destructive work. The bark is gnawed from the small trees, often girdling them. Early settlers found it necessary to have rabbit drives. Preparation was made by building a long funnel-shaped fence. The event was made a gala occasion; everyone was invited to take part. Men on horseback swarmed across country driving the rabbits within the fence. Rounded up in the small pen at the apex, the rabbits were slaughtered with clubs. Thousands of rabbits were thus eliminated as competitors for the rancher's crops. Occasional

drives are still held. The "harvest" is sent to market and pays the expenses of the drive.

The jack-rabbit is a true hare. It lives above ground and the young obtain only the shelter of a bush. Adaptation for this form of life is seen in the well-haired and well-developed young which have to remain in the nest but a short time. Though withstanding the high temperatures of the summer, the jack-rabbit seeks the shade during the middle of the day. From the window of a train on a day in midsummer one sees jack-rabbits enjoying the shade of fence posts along the right-of-way. Nor are they likely to run from their cool spot as the train passes.

The Indians of California might have used the beaver as extensively as did those of the East, for this animal was once very abundant. Now it is making its last stand in the marshy regions of the Great Valley. Because of its color, it has been named the golden beaver. As a rule, its home is a burrow in a bank, though not infrequently a typical beaver house is constructed. This burrowing habit has furnished cause for legislation that threatens its existence. Extensive marsh reclamation projects in areas where it makes its home have led to the building of dykes and levees. The weakening of these levees through tunnelling by beavers sometimes causes inundation of areas under cultivation. So strong have been the representations against the beaver in recent years that protection was taken from it after it had enjoyed the privilege of a close season for a term of years sufficient to make the numbers of these animals conspicuous. As soon as protection was removed nearly three hundred beavers were trapped in Madera County and an equal number along the Merced River in Merced County. As a result the golden beaver is fast becoming one of the rarest fur-bearers in the state.

On winter nights there is a chorus of sound that comes from every mud puddle. If one approaches, the sound sud-

denly stops. The croaking of the tree toad is so associated with rainy weather that this amphibian is often called a "weather frog." The sound which is like "k-r-e-e-k - eek" is very loud considering the size of the animal that gives it. The smallest of its kind, it gives the loudest notes. The tree toad is seldom two inches in length. The sound is reenforced in the male by a large air sac which is dilated with air and becomes a resonator. Investigation in the daytime will reveal a small frog-like animal, which may vary in color from gray to light green, with a black stripe through the eye. On the tip of each toe is a sucking disc which enables the animal to cling to a grass blade or other vegetation. Great quantities of eggs in a jelly-like mass are left in the water until they hatch into the familiar tadpoles to be seen in every pond.

Under rocks and boards in winter may be found the slender salamander, California's smallest amphibian and smallest land vertebrate. Moisture is demanded by this salamander and when it is not available at the surface it disappears underground to reappear when rains make conditions suitable. The legs are so small that they act largely as pushers. The tail is round and about as long as the body. When captured this salamander twists and turns, giving peculiar contortive movements perhaps useful in escaping its enemies. Slender salamanders keep well hidden in the daytime and it takes search to find them. At night they move about hunting for food: beetles, earthworms, and similar crawly things. The "water dog," properly California newt, is a reddish lizard-like creature which frequents streams or their banks and is helpful in the destruction of mosquito larvae. None of the salamanders in California—and there are several kinds—are poisonous to touch, no matter how replusive they may look. Though toads and frogs may be noisy, salamanders seldom make a sound.

Chaparral

Originally much of Southern California and the foothill regions of the rest of the state as well, were covered with a dwarf type of vegetation. To the average person this brush belt is known as the chaparral; to the scientist as sclerophyllous woodland. It is usually described as a mixed forest of trees stunted because of peculiar climatic conditions. In some ways it represents an intermediate type of growth between typical forest and dwarfed desert vegetation. The name chaparral is attributed to "chaparro," the Spanish name for live oak. Perhaps the familiar "chaps," protective apparel of the vaquero, got their name from the effort made to protect the rider from the brush oaks and other shrubs through which he had to ride.

The dwarfing of plants can usually be attributed either to low temperatures or lack of moisture. In the case of the chaparral, dwarfing results from deficiency of moisture, together with other conditions having to do with wind, barren soil and rapid evaporation. The assemblage of plants making up the chaparral lacks typical forms from northern latitudes, also distinctively tropical types.

In territorial extensions the chaparral rivals typical forest. In the southwestern United States it covers almost all of the mountainous regions of the southern half of California, extends far into old Mexico and even invades portions of Nevada and Arizona. However, it is in California that it reaches its highest degree of perfection. It often stretches a score of miles in unbroken form and its upper limit may reach an elevation of six or seven thousand feet.

The winter supply of moisture starts growth, but because of the short rainy season and the severe summer heat, the growth is retarded. Consequently, the woody branches are tough, hard and often crooked. Shrubs, twenty-five years or more in age, may be but five or six

feet high and but two or three inches in diameter. Leaves are apparently needed the year through and most chaparral shrubs are evergreen. This does not mean that the leaves are always green in color, for fading colors are noticeable with the advent of the dry season, and in the fall the chaparral takes on a brownish color. With the first rains there is a rapid change to green.

Here shrubs crowd so closely together that one can hardly force one's way through the thicket. Jepson says of the chaparral: "The various shrubs which go to form this close cover are of much the same stature and aspect and form a remarkably uniform population on exceedingly dry and well-drained slopes. The excessive drought, the high summer temperature, and the rocky or gravelly nature of the soil are the chief factors which have caused these various chaparral shrubs to develop many characteristics in common; of these the most striking are their dwarf habit, reduced leaf surface, small flowers, hard, close-grained wood, and rigid thorny branchlets. It is only superficially, however, that these shrubs are alike. They are derived not from one family, nor two, nor three, but represent the pioneer spirit in many different stocks which have successfully met the conditions imposed by Nature in the chaparral area."

Respect for the tough, rigid growth comes with just one experience in crossing a ridge with no trail. Try it! First your foot slips on the smooth manzanita. Next you trip over a low limb and by the time you pick yourself up a limb of baccharis or greasewood springs back and lets you know of its presence. Dissatisfied with your progress you try the ground route on hands and knees. This also proves rough, uncomfortable going with many a resort to flattening yourself to avoid low limbs. Yes, one's respect grows with such an experience.

In the chaparral we find a satisfactory cover for semi-

arid lands. Roots prevent erosion and help the water to percolate deeply into the soil, the leaf surface and shade lessen the evaporation; the well-known character of density is of great importance. Therefore, in the regulation of streams and in aiding the storage of water, the elfin forest is essential to semi-arid regions.

Fire appears to be less of a menace to the chaparral itself than to the more important consideration of water supply and feed for animals, for nearly every species of plant concerned quickly sprouts after a fire, assumes a respectable growth in four or five years, and attains full growth in about twenty-five years. Both foliage and wood burn easily and a brush fire is the most difficult of forest fires to control. Only on the crests is there a chance of stopping such a fire, so firebreaks wind up along the ridges. So grave is the danger from brush fires that in the national forests of Southern California the number of fire guards is greatly increased during the fire season and every precaution is taken to prevent the starting of one. Rules have become more rigid with the years and special permits to build fires are required and smoking is prohibited except in established camp grounds.

The most abundant and widely distributed plant in the chaparral is chamisal or greasewood, *Adenostoma fasciculatum*. Spanish-Californians termed it "chamise" and many still speak of any brush-covered area as "chamise." The plant has small, almost needle-like leaves, and little shade is produced. Occasionally a shrub ten feet high is found. A late bloomer, in June it whitens the mountain sides with racemes of minute flowers; the term greasewood is not amiss when it is remembered that this shrub makes excellent firewood; likewise, it is the most dangerous component of the elfin forest when a brush fire rages. Progress through a thicket is difficult.

Second in importance are the shrubs commonly called

"wild lilacs." The scientific name, ceanothus, is becoming common usage. Some species produce beautiful lavender or purple flower clusters, while the common buckthorn produces white ones. Some forms are very thorny; practically all of them furnish good browse for deer and for cattle as well.

The manzanitas stand out among the other shrubs because of the crooked, red-brown branches which shed a papery bark, leaving them smooth and shiny. The fruits resemble apples in shape and hence the name which is Spanish for "little apple." The story goes in California that twenty-five dollars awaits the person who can find a perfectly straight branch the length of a cane. Certain it is that this beautiful mahogany-colored hard wood of the manzanita makes suitable material for a cane. By choosing large trunks and digging out the root as well, canes have been quarter-sawed from such a stub.

The holly-leaved cherry, sometimes called California wild cherry or islay, has been duly recognized as one of California's most beautiful shrubs for it is widely and most satisfactorily used in landscape gardening. The grounds of the Chaffey Union High School at Upland have a choice display of this shrub. The leaves are so crinkled and toothed as to remind one of the true English holly; even the species name *ilicifolia* describes this character, the first half of the word meaning holly and the second half, leaf. The fruit, of a dark purple color, is edible but there is much seed and little pulp. Though one might fail to recognize the beauty of this shrub in its native habitat in a dry arroyo, yet when planted as a hedge one cannot pass by without admiring it. The cut branches make the best of indoor decorations. In the South it is used as much as huckleberry is in the North and it has the same lasting qualities.

Most of the larger-leaved well-foliaged shrubs of the

chaparral are sumacs. Several species produce flat, reddish berries much eaten by birds and also utilized by Indians and Mexicans. One of them is actually known as the lemonade berry because of the acidity of its fruit, which is used in producing a drink. Most of the sumacs produce abundant, thick, leathery green leaves and consequently furnish welcome shade. Probably the best known member of this family is the poison oak. Californians have reason to know this plant because of the severe skin irritation which it causes. The uninitiated, attracted by the beautifully colored autumn leaves which the shrub bears, sometimes pick branches for decoration and suffer the consequences. Much time and effort have been expended in an attempt to discover a useful preventive or cure. The old Spanish Californians believed that immunity could be established by eating small quantities of the leaves but some who tried found this a dangerous proceeding. Modern remedies appear to be based on this old theory, for extracts of the plant are given internally and also injected into the blood.

Every Christmas brings to market the so-called California holly or toyon. The beautiful bunches of red berries are in their prime just before Christmas. Though no relative of the true holly, this member of the rose family produces a berry just as decorative, but the leaves are not so attractive. In many places toyon bushes now fail to produce a crop of berries owing to the continual picking. Branches have been broken off until only the stubs of large branches remain and these fail to produce the bright red berry so much in demand at Christmas time. Conservationists noting these conditions succeeded in enacting a law which prohibits the picking of toyon berries without the permission of the owner of the property. As a result the toyon was the first shrub granted legislative protection in California.

In the Sierran foothills and in the Coast Range, the commonest shrub is a baccharis, occasionally called "mule fat" and "chaparral broom" or "fuzzy wuzzy." It is much branched, heavily foliaged and makes ideal nesting places for several species of birds. The bloom, which is of composite type, is hardly as noticeable as the resultant fluffy seeds. In many ways the chaparral growth of the northern part of the State differs from that of Southern California.

Occasionally one comes upon a shrub or even a tree covered with long, feathery plumes, which are found to be attached to the seeds. At most times of year it is an inconspicuous shrub. The heavy dark-colored wood has drawn to this plant the name mountain mahogany (*Cercocarpus*).

In Northern California the redbud, *Cercis occidentalis*, is conspicuous in spring because of a cloud of red blossoms which clothe each branch before green leaves appear. The shrub, found in the foothills of the Sierra and also in the Coast Range, belongs to the pea family, the purplish pods of late summer and fall proving it. The sweet scented shrub, *Calycanthus occidentalis*, has large aromatic leaves and red and brown sepals and petals on a cup-like base, the flowers slightly resembling chrysanthemums. The urn-shaped pods persist and decorate the bushes for many months. The distribution is similar to that of the redbud.

The wild currant blooms in midwinter. Soon after the first fall rains the shrub breaks into bloom and the pink or yellowish flowers, for there are two kinds, each with a distinctive coloration, give the first patches of color to the hillsides. The currants themselves are not very palatable to most people and are left for the birds. Wild currants are often used as ornamental shrubs in California gardens and are most satisfactory both from the standpoint of foliage and blossom.

The pioneer Californian soon became acquainted with yerba santa, the saint's herb. It was considered a cure-all and the steeped leaves made a bitter, pungent medicine. It is still marketed. Yerba santa grows abundantly in the chaparral belt. A number of three or four-foot stalks sprout from a perennial root and bear alternate thick shiny leaves. Those who like pungent, unusual tastes chew the leaves, which are recommended as a thirst-quencher. Every boy knows that a drink of water afterwards tastes as sweet as sugar, a relief for the sting left on the tongue. As boys, my comrades and I made "plugs of tobacco" with the leaves and carrying them in our hip pockets "took a chew" of "Indian tobacco." Tubed flowers of a lavender or whitish color appear at the top of each stalk. In some places yerba santa bloom adds patches of color to the landscape.

When in bloom, the chaparral furnishes both color and fragrance. Creamy white color predominates, but the wild lilacs, sages and other shrubs add a touch of blue. The manzanita is most attractive with dainty pink bell-shaped flowers. Just as the crushed leaves furnish spicy aromas so the flowers scent the air with a distinctive odor, sometimes too pungent for delicate nostrils. As Ellen Burns Sherman has pointed out: "Nature from her same old mixing-bowl of brown earth, stirred by long sunbeam fingers, can produce a million different odors." Certainly the fragrance of chaparral in bloom is the result of the blending of a hundred spicy aromas rather than a delicate perfume, but one of a graded series.

A "bristling hemisphere of hostile bayonets" is suddenly transformed into a ten-foot stalk and spire of fragrant white flowers in the case of the yucca. After a prosaic life in the chaparral of dry arroyo or mountain-side, of two or more years, a stalk which grows nearly a foot per day and on full growth bears a fragrant mass of bloom

at its summit catches the eye at a great distance. Not infrequently, the flowering stalk has gained its full growth inside of ten days. In fact no other plant of the chaparral furnishes so conspicuous a bloom that tops surrounding vegetation; more than 900 flowers have been counted on one stalk. The Spanish Californians named it "our Lord's candle." The leaves, which end in a spine, giving it the name of Spanish bayonet, are capable of severe injury to man because of the danger of blood poisoning.

The satiny white flowers, which are exceedingly attractive, grow in interest with knowledge of the strange method of fertilization which forms so striking an example of the interdependence of plant and animal life. Apparently the production of seed in this plant is entirely dependent upon an insect, a moth, which forcibly fertilizes a flower with pollen taken from another flower. A female pronuba moth with specialized mouth parts scrapes together the sticky pollen into a ball and carries it to another flower where the insect rubs it on the inner surface of the stigmatic tube, thus making fertilization sure. This same female lays her eggs in the seed cavity of the newly fertilized seed pod. As a consequence, developing seeds furnish the food supply of the larvae which hatch from the eggs. An unfertilized flower would of course fail to furnish necessary food. On sufficient development the larva digs out of the pod, fastens a silken thread to it, and descends to earth, where it buries itself at the foot of the plant. After a dormant life in the soil for a season, the pupa-case bursts and an adult moth issues forth in its turn to make complete the life cycle of a yucca.

The stalk of the yucca, so often cut up and sold in curio stores for pin cushions, had and still has many uses. It furnishes materials for the making of soap, fibres for rope, baskets, and mats. Fibre for the making of boxes is furnished by the leaves. Indians utilized the seed for food

and the fruit for an alcoholic beverage. Furthermore, the newly growing stalk when roasted furnished a great delicacy said to be as sweet as molasses. Sheets cut from the pulpy stalk have been widely used as a protective device for young trees against rodents and sunburn.

Through the foothill region with its brush-covered slopes runs that famous gold-bearing strip, known as the Mother Lode, first discovered by the forty-niner. By plotting the gold mining district of California, one finds a long belt but a few miles wide extending along the greater part of the western flank of the Sierra Nevada. Here it was that the miners found slate veined with quartz, and in the quartz was found gold. The gold that had been mined out by streams through the ages could be reclaimed by placer mining. A trip to this region at the present time shows a few mines with their accompanying stamp mills still in operation, but everywhere are ghost towns reminiscent of prosperous times, now with buildings forlorn and empty. Broken-down store buildings of brick with iron doors, cabins with broken window-panes and occupied only by wood rats, cluster amid elms and locust trees which remind us of the hopes of the pioneers. The nearest red-colored hills are marked with the ditches and the resultant piles of rocks left by the placer miner. But this desolation is not to be compared with the devastation left by the modern gold dredger. Fine river-banks, upland richly covered with vegetation, and even orchards planted and cared for with endless toil, become great piles of rock thirty feet high, acres and acres of them, with here and there an old pit filled with rain water where frogs make the night hideous. The changed landscape as a result of modern methods of mining cannot fail to disturb any lover of the outdoors.

Animal Life of the Chaparral

A huge pile of sticks three to five feet high in the midst of some bushes indicates the presence of the wood rat. The nest is occasionally placed in a tree, for some species are good climbers. Seldom is a wood rat to be seen in daylight unless driven from a nest. Several rooms are provided within the stick nest and usually there are burrows arranged beneath to increase safety. Some wood rats prefer a cleft in rocks and use much less building material. As a rule but one animal occupies the large nest, but nests are often close together and the runways interlock. As the numerous tracks indicate, wood rats are very industrious, making many trips for food each night. Sometimes a low limb is used as a runway.

One need not think of the detestable house rat in connection with this beautiful grayish silky-haired animal with a hairy tail. Though the wood rat is troublesome at times in a cabin, it more often sticks to its home in the brush. "Packrat" and "trade rat" are names given it because of a habit of carrying articles from place to place. Collections of articles toted to the loft of a cabin have netted everything from hairpins to combs and spoons. At times a wood rat thumps with his hind feet, much like a rabbit. Many "rappings" in deserted cabins attributed to "spooks" might better have been interpreted as rappings of a wood rat.

This type of rat is found only in North America and is much more abundant in the West than elsewhere. Of several different varieties, the Streator wood rat occupies the chaparral belt; the bushy-tailed wood rat, rocky places in the higher mountains, and the desert wood rat, the desert.

In Mexico, where wood rats are abundant, they were formerly sold in the market. After being caught the lower

teeth were broken off so they could be handled safely; they were then placed in a sack and sold alive as a delicacy. The meat is said to taste very much like rabbit.

Brushy foothills cannot be entered without noting a peculiar loud whistled call beginning slowly and resulting in a trill, pit-pit-pit-pit-tr-tr-tr-r-r-r, exhibiting the rhythm of a marble bounced on pavement. The wren-tit is the bird responsible. A close view as it moves about in the brush will show a bird about six and one half inches long, uniformly brownish gray with the exception of the grayer breast, with a short slender bill and long uptilted tail, and white eye. The bird received its name because of its titmouse-like bill and its wren-like tail. The song above described is varied by omitting the terminal trill. Call notes are rasping in character and sound somewhat like those of a wren. No bird is more typical of the chaparral belt. Chaparral limits its distribution and its range is chiefly restricted to California. Seldom is the bird seen on outer twigs; it spends its time skulking and hiding in the maze of thick branches within the foliage. In such a situation the bird must needs be a good climber and so we find it moving about with chickadee-like agility.

The wren-tit so differs from other birds that it is placed in a family by itself. Apparently it has come down to us with no close relatives in America; perhaps it had its origin in Asia. Thus, in the wren-tit, California may boast of the only bird family peculiar to America.

"What were the little gray birds that moved about in bushes in my yard, like little mice?" This question is often asked by the resident of California who has not made the acquaintance of the bush-tit, one of the commonest birds of the chaparral. Next to the humming-bird the bush-tit is the smallest bird.

Bush-tits move about in the shrubbery and trees search-

ing for scale and other insects, often hanging head down like a chickadee. Since government investigators found sixty black scale in one stomach, everyone has been convinced of the value of this tiny bird. Even tiny insect eggs are searched out among the leaves. Minute insects like plant lice are gleaned from rose bushes. In winter, flocks of twenty to fifty birds move about in the shrubbery. By means of a continually given call-note the birds keep track of each other. When one bird gets separated the call-note is changed in volume and pitch and an answering call from some member of the flock, which has perhaps moved to another tree, allows the straggler to find his companions. When a hawk tries to pick a bird from a flock all of the birds give a peculiar high-pitched note, the while "freezing,"—remaining perfectly quiet. This has been described by Dr. Grinnell as a "confusion chorus." No movement betrays a bird and if the hawk follows sound it does not know where to turn.

In moving from tree to tree or bush to bush, bush-tits troop across the open space one after the other with an undulating flight.

The nest of the bush-tit is a work of art. Supported at the top it forms a bag six to ten inches long and three to four inches in diameter. The entrance is near the top on one side and the interior is lined with feathers or less frequently with plant down. Lichens form the main structure and the whole is held together with spider webs. Watch a pair of bush-tits as they build and you will note that trips are made for lichens pulled from tree trunks and then often in another direction for spider webbing. The nest is started as a cylinder and when long enough is pulled together at the bottom and the lining inserted. Mr. Dawson describes a nest decorated with the golden blossoms of the acacia tree. Thick foliage of a live oak is the location most often chosen, though nests are sometimes hung

in shrubs but a few feet above ground. Boys sometimes call the bush-tit "hang bird" because of the hanging nest.

The bush-tit must have numerous enemies if the rate of increase is a criterion. From five to nine eggs are laid. Both parents feed industriously in caring for such large families. To see a full-sized family of little ones emerge from a nest for the first time is a rich experience.

In the pioneer days of California, every vaquero knew the Queleli, or California condor. The great size of the bird and its soaring flight gained the respect and admiration of all. Since this bird was seldom seen in the open, like the more familiar vulture of the West, the turkey buzzard, it was the mountaineers who knew and recognized it. Now it is such a rare bird that it is seen principally by bird students who know where to search for it. One condor, named "General," was on display in the New York Zoo for nearly twenty years, giving some city residents and bird students an opportunity for close study. A few museums possess mounted groups.

Among the many varieties of vultures known in the two Americas, two may claim attention because of their large size, the Andean condor (*Vultur gryphus*) and the California condor (*Gymnogyps californianus*). A specimen of the former in the California Museum of Vertebrate Zoology taken in the southern Andes measures 48.8 inches in length and 116.9 inches in extent (wing tip to wing tip). The largest of four specimens of the California condor measures 50 inches in length and 115 inches in extent. Exaggerated statements as to the spread of wing are common in literature. Apparently, the North American and the South American condors average very nearly the same size. Weight of California birds has varied from 20 to 26 pounds. There are, however, a number of differences in appearance. The South American bird has a ruff of snow-white down at the base of the neck, has a white bar a-

cross the secondary wing feathers, and a comb and wattle on the bare head; otherwise the bird is black. The California condor lacks these adornments and has only a stripe of white underneath the wing in the adult bird.

The California condor originally ranged from British Columbia to Lower California. Through the years the bird has disappeared in most of its former range and now is to be found only in a few mountainous localities in California, and, perhaps, Lower California. Within the past ten years a dozen or more birds have been seen in flight at one time in Ventura County, but it is doubtful if the total population far exceeds a hundred. Apparently the desire of men to kill this great bird in order to brag of its size, perhaps coupled with the fact that the quills were highly prized for carrying gold dust during mining days, and in addition, the slow rate of reproduction, and the diminishing food supply, are some of the factors bearing on its decrease.

The nest of the condor is placed in a cleft of rock on some mountainous cliff. Many fanciful tales have been circulated regarding the condor, perhaps the most notable being that the eggs were round in shape and dark in color. Actually the single egg measures 4.5 by 2.5 inches and is whitish and unmarked. The single young bird is covered with snow-white down and remains in the nest for many months before capable of flight. In one instance recorded by Finley it took six months to mature flight-feathers. The time elapsing before the bird reaches maturity is evidence that it is long-lived as compared with smaller birds. No evidence is at hand as to the actual age reached by wild birds.

The best description of the nesting habits of the California condor appeared in print in 1906 under the authorship of W. L. Finley, and there have been few original contributions since that time.

The State of California first gave protection to the vanishing California condor in 1901 when a law was enacted giving total protection to all non-game birds. More recently it was found necessary to curtail the operations of collectors of bird specimens and eggs, because of the high value placed upon this rare bird and upon its egg. Consequently, all scientific collector's permits issued by the California Fish and Game Commission carefully except the condor, thus giving this notable vulture, largest of land-birds in North America, as complete legal protection as is possible.

The future of this bird, for the safety of which the State of California is responsible, not only rests upon legal protection but upon knowledge of its life and habits in order that biological requisites of food and safe breeding sites may be afforded it. May the California condor continue to whet the interest and imagination of bird students through the years and never follow to oblivion the larger prehistoric vulture, bones of which have been found near Los Angeles! The golden eagle, like the condor, frequents the brushy foothill region, though also found in the higher mountains. Its size and magnificent soaring flight appeal to every observer. Man has ever yearned to emulate its lofty flight, its courage, its strength, and love of freedom. The valleys of California and their environs are dusty and hot only to those who fail to appreciate their beauty and their richness in plant and animal life.

Chapter IV

CHAPTER IV

Mountains Rocky, But Inhabited

Nevermore, need one weary or faint by the way
who gains the blessings of one mountain day.
No matter what his future, long life, short life,
stormy or calm, he is rich forever.

—John Muir.

NO NATURAL RESOURCE of California can vie with the high barricade of mountains that separates California from its neighbor on the east. To this mountain range the state owes both climate and water supply. The high snow-covered peaks of the Sierra Nevada awed the Spanish explorers and drew from them the appellation of "snowy range of mountains" (literal translation from the Spanish: "snowy saw-teeth"). A map by Pedro Font bearing the date of 1777 was the first to label the range clearly.

Long known to various Indian tribes that camped in summer in the meadows and occasionally crossed the summit still unnamed, this great mountain range did not take its place in history until Pedro Garcés visited the Indian rancherias (as the villages were called) in 1776, the year the Declaration of Independence was signed. Spanish explorers and settlers appear to have known only the lower reaches of the streams. To these they gave names. Some

have been shortened, as for instance that of the Merced, which originally was named El Rio del Nuestra Señora de la Merced (the river of our Lady of Mercy), having been discovered after a long exhausting waterless journey of forty miles. Likewise Rio de los Santos Reyes has been shortened to Kings River.

The range long constituted an unsurpassable barrier between the East and the West. Two American trappers were the first white men to cross the Sierra. In 1827 Jedediah S. Smith, with two of his men, took fully eight days to make the trip from west to east. Six years later Joseph R. Walker crossed in the opposite direction, supposedly just north of the Yosemite region. The early explorer Frémont named several rivers and passes for members of his party and the State Geological Survey parties under Whitney continued the custom so that we find most of the peaks, lakes and meadows bearing the names of various pioneers. The Indians apparently did not have names for the peaks. Usually the rivers were named by them and consequently we find such names as Tuolumne and Kaweah persisting.

Pathetic reminders of many an emigrant train which met difficulty in crossing the Sierra are yet to be found in many places, sometimes in the form of some such name as Donner Lake, Emigrant Meadows, Relief Meadows, Carson Pass, or in the form of metal parts of abandoned prairie schooners.

So vast a literature on the Sierra Nevada has grown up through the years that the library in Yosemite National Park is specializing on Sierra Nevadana, if it may so be described.

Originally inaccessible, the range is now traversed by two railroads and at least seven "wagon" roads. Several other trans-Sierra highway routes have been proposed and will ultimately be constructed. The most spectacular

crossing is that through the Yosemite region over Tioga Pass and this will probably be eclipsed by the proposed one in the Mount Whitney region.

Real appreciation nowadays more often accompanies the unique rather than the beautiful. The Sierra should be appreciated because of its rare beauty. John Muir described these mountains in the words, "as beautiful as a rainbow, yet firm as adamant." Certainly to me no area is more majestically beautiful. No area contains more splendid peaks, mighty cañons, blue glacial lakes, and flower-grown meadows.

Yet, lest more spectacular features of the range be overlooked and appreciation dwarfed, other claims for notice are worth mentioning.

Although the average person associates the Mount Shasta region with the name Sierra, the geographer terminates the Sierra Nevada at Mount Lassen and calls its northward continuation the Cascade Range. Even if we omit Mount Shasta, incomparable type of extinct volcanic cone, with its glaciers, mammoth springs and ice caves, there still remains within restricted definition the only active volcano in the United States. Lake Tahoe is to be numbered amongst the largest of the high mountain lakes of the world, although hardly comparable in size with Lake Titicaca in the Andes of South America. Southward the range furnishes us with the highest waterfalls, deepest glaciated cañons and most massive granite cliffs and domes. The superlatives are not at an end. This longest, highest, grandest single mountain range in the United States culminates in the highest summit, Mount Whitney, 14,501 feet above sea-level, and adjacent thereto is the deepest hole in the continent, Death Valley, 200 feet below sea-level. The two sides of the range form a contrast: on the west is verdure and fertility, on the east, barrenness and sterility. The one side gets

a satisfactory rainfall, the other famishes and becomes desert. No mountain range has such extensive or distinctive forests, nor trees comparable in size. No range displays more interesting animal life.

Our first word picture of the Sierra may well be taken from that genuine classic of American literature, "Mountaineering in the Sierra Nevada," by Clarence King.

"By far the grandest of all these ranges is the Sierra Nevada, a long and massive uplift lying between the arid deserts of the Great Basin and the Californian exuberance of grain-field and orchard; its eastern slope, a defiant wall of rock plunging abruptly down to the plain; the western, a long, grand sweep, well watered and overgrown with cool, stately forests; its crest a line of sharp, snowy peaks springing into the sky and catching the *alpenglow* long after the sun has set for all the rest of America."

We all hear so much of the Alps that even though we have not had personal contact with them, a comparison by those who have climbed those snowy peaks in Switzerland, and again the higher peaks of the Sierra, makes us appreciate our own Alps. The Matterhorn exceeds Whitney by two hundred feet and four other peaks in the Alps come near to or surpass the 15,000 foot level, notably Mt. Blanc with an elevation of 15,731 feet. Yet in the Sierra fourteen peaks rear their summits above 14,000 feet and a host of others surpass the 13,000 foot mark. Though the Alps have a greater variety of form and greater snow masses, our own Sierra is richer in color and all life is more prolific; the forests are extensive, bird, animal and insect life abundant. The great cañons of the Sierra, glacier carved, but in which rivers of ice have been replaced by foaming torrents, furnish glorious granite cliffs and hold flower-grown meadows and magnificent forests.

Those who know both admit that whereas the Alps furnish perilous mountain climbing for those who demand

dangerous and alpine-guided ascents, the Sierra is more friendly, bringing peace and contentment to visitors. Inviting rather than forbidding, the Sierra has a well-earned reputation of making cares and responsibilities fall away and soothing her guests with sublime feelings of exhilaration and content.

Carter A. Harrison, former mayor of Chicago, is quoted as saying: "I have crossed the Andes three times, by three different passes. I have been in the Himalayas and have seen Everest from Darjeeling. I have tramped in the Pyrenees and have been in the Alps more times than I can count. And I tell you that in all the world there is nothing so beautiful as the California High Sierra, from Yosemite to Whitney."

I once took an uncle who had lived his entire life on the plains of the Middle West, up into the mountains. I will never forget his awe and his poor attempt at expressing it, "Jemimi! Look at that," as he wiped the perspiration from his brow. He could not believe that there could be such enormous piles of rocks even with the evidence before him. Behind every mountain there lies another larger one, range on range, till the snow-covered summits are reached.

After contemplation of size and a thought of their beauty, to every inquiring mind come the questions: How did the mountains come to be? What forces are great enough to create mountains?

Geological History and Structure of the Sierra Nevada

When we studied geography we were told that, just as the skin of an orange wrinkles as it dries and shrinks, so the earth's surface on cooling has made wrinkles we call mountain ranges. Many mountain ranges are simple folds in the earth's crust. Not so the Sierra Nevada. Like many ranges in the Great Basin plateau region, this range was

formed by the breaking and tilting of a great block of the earth's crust. Only such an explanation will account for its configuration.

The geologic history of the Sierra goes back millions of years, nobody really knows how many millions, to a time when the whole area was under water. Sedimentary rocks which could have been formed only under such conditions, and fossil shells, bear witness to this far distant time. An enormous thickness of rock, layer upon layer, was formed. Then followed upheavals that left a low mountain range, which in turn was reduced to low rounded hills. Streams apparently ran in a north or south direction, judging by the way old stream beds are cut by present westerly flowing rivers. The geologist speaks of the rolling character of the country as a peneplain. Next came a breaking of the earth's crust and the forming of a high mountain range. To understand the process of faulting and tilting of the Sierran block, imagine a cement sidewalk fifty feet long, four feet wide and six inches in depth. Suppose this sidewalk, at first level with the ground, is tilted on its longest axis so that one long edge is a half foot above the level of the ground. There is then a gradual slope up the four feet of surface and a six-inch drop off on the far side. Now change this picture to a section of the earth's crust 400 miles long and 80 miles wide. The westward slope of the Sierra is a long gradual one; the eastern, a precipitous one where the faulting took place. The great height of the eastern face is partly due to subsidence of the area to the east. The base on the east is buried with eroded materials. As recently as 1872 a ten-foot fault, accompanied by a severe earthquake, developed in the Owens Valley, reminding us that the Sierra block is not static. These comparatively young mountains are still growing, and growing faster than others of the United States. Because mountain ranges of this sort are so com-

mon in the plateau region they are termed basin-type ranges.

During the faulting process there welled up into the break in the earth's crust a great mass of igneous rock forming a granitic magma. Geologists estimate that it takes 6,000 feet of sedimentary rock as roofing to furnish heat and pressure enough to form the rock we call granite. Sedimentary rocks overlaying the granite of the Sierra, slates and schists mostly, have been largely carried away by erosion. The foothills display the old sedimentary rocks and the great valleys are filled with rock debris of this type. Consequently, with the older rocks removed, granite is seen everywhere. Only along the ridge do we find remaining some of the old superimposed rock.

Streams through the ages have cut deep westward flowing cañons, eleven in all, many of them two thousand feet deep. The initial sculpturing was done through the agency of water; the more recent sculpturing by ice. These cañons are spectacular and form the most scenic feature of the whole range.

The western side of the continent along with the eastern experienced a distinct change in climatic conditions some twenty thousand years ago. Either there was greater precipitation or a lowered temperature. Snow was piled deep along the crest of the Sierra, feeding great glaciers that swept down the old river valleys, cutting them a thousand feet deeper and changing the water-cut V-shaped cañons to glacial-cut U-shaped ones like those of the Merced and Kings rivers. Moraines, erratic boulders, polished rocks, glacial cirques and tarns all bear witness to the agent which left a more recent impress on the cañons and the summit region. Recent studies based on age of morainal material indicate that there were two distinct stages of glaciation separated by a long interval of non-glacial conditions.

Since the ice age, the changes in configuration have been comparatively small. First, most of the old U-shaped cañons filled up with water behind terminal moraines left by the glaciers, making lakes. The lakes were gradually filled in with sediment carried by the streams that traversed them. Next in the cycle came marsh conditions, next meadow and lastly the final stage as we know it, a flat valley floor overgrown with coniferous forest. Meantime glacial polishing has weathered from the cliffs; great piles of rocks have accumulated at the base of the walls, forming talus slopes; the walls have become roughened and sculptured and covered with lichens and even a growth of shrubs and trees.

This, briefly, is the history of this great mountain range as the geologists have worked it out for us: the tilting of a great block of the earth's crust; the erosion by water of deep westward running cañons; a change in climatic conditions that developed glaciers which in turn cut the cañons deeper and straightened up their walls; and finally the filling in of glacial lakes and weathering of the cliffs.

The Coast Range

The coast ranges received their first folding in Cretaceous times, only to be submerged and crowned with thousands of feet of sedimentary deposits, all of which took unknown years to be accomplished. At the end of the Miocene time a folding and crushing process furnished the general configuration. Later, tilting, and a still later outpouring of lava gave this range its main features.

The mountain ranges of Southern California are more complicated, sometimes considered a continuation of the Coast Range and again a part of the Sierra Nevada. Most of them are transverse to the main axes of these ranges. Present views associate the San Gabriel, San Bernardino

and San Jacinto with the Sierra Nevada, and the Santa Monica and Santa Ana ranges with the Coast Range.

Imposing Peaks

Because it dominates the landscape for a hundred miles, Mount Shasta is the most imposing mountain peak in California. Technically it does not lie in the Sierra Nevada. Nor is it an integral part of the Cascade range usually described as running northward into Oregon from Mount Lassen. Rather does it form the focal point from which radiate the Cascades to the north, the Siskiyou-Klamath mountains to the westward and the Cascade extension of the Sierra to the southward. This massive cone rears its snow-capped summit 14,162 feet above sea-level. Because 10,000 feet of its height rises sheer from a forested plateau, now traversed by a main line railroad, Mount Shasta assumes a commanding position unsurpassed by other peaks. For this reason it was long erroneously assumed to be California's highest mountain. In the Sierra, a dozen peaks and many ridges curtail the view. From the summit of Shasta the view is uninterrupted in every direction.

Although viewed by the early Spanish explorers and by fur-trapper Peter Ogden, Mount Shasta was not climbed until 1854. In that year several pioneer settlers of a nearby town were led to the summit by J. D. Pierce, who previously had made the ascent alone. Since then many have reached the summit. Two at least had memorable experiences. John Muir and a companion in 1875 were forced to spend thirteen uncomfortable hours in the hot spring near the summit during a blizzard. Imagine yourself scalded on one side and frozen on the other! Attempts by the Coast and Geodetic Survey to flash heliographic signals from the top of Mount Shasta to Mount St. Helena, 192 miles to the southward, necessitated B. A. Colonna's

spending nine days and nights on the summit, delay being occasioned by the smoke from forest fires.

Mount Shasta is preeminent as an example of an extinct volcanic cone. Extinct now, it may some day renew activity as has Mount Lassen. If we may judge by Indian legends it once furnished fireworks for primitive Californians, for the mountain is described as a great wigwam, the dwelling-place of the Great Spirit whose lodge fire was seen to smoke by day and burn by night.

The geologist's explanation of the mountain's history, as given by J. S. Diller, is as follows: "Mount Shasta is a great accumulation of volcanic material about the vent from which it issued. The larger portion of the mass is made up of coulees or streams of molten lava that welled up in the throat of Mount Shasta to the surface and overflowed from the crater on top or burst through the crater wall and reached the surface by a fissure in the mountainside. The volcanic activity of Mount Shasta began in early Tertiary time (Eocene) and continued by alternative active and quiet periods for many millions of years upbuilding the mountain. Most of the activity was effusive, pouring out flows of lava one over the other, but there was also much material ejected in the form of volcanic ashes and pumice by explosive action which produced in many places layers of fragmental material between the sheets of lava." Black Butte, the only nearby mountain, probably had a similar history.

Even without the display of an eruption Mount Shasta has been able to furnish stupendous changes in her contours, and demonstrations of the giant forces controlling nature and the comparative littleness of man. A series of dry years caused one of the four glaciers which surmount its crest to melt rapidly in the spring of 1924, with consequent destruction of water works and habitations, and the discoloration of the McCloud, Pit and Sacramento

rivers for many miles as a result of debris. Masses of ice as large as houses breaking from the glacier would avalanche down the cañon, leaving tons of debris at the mouth, where a great slope of glacial sand seven miles long and a mile wide was formed. This mud flow constitutes one of the most vivid examples of rapid erosion.

These may be the more spectacular contributions which have drawn attention to this great mountain, but if living things prove to be of still greater interest Shasta can furnish them. Long ago found to have a distinctive fauna and flora, one may get the thrill of re-discovery by searching out some eight plants and at least two mammals that are endemic to its slopes. Here one may find with sufficient search the southernmost examples of the Engelmann spruce. With less exertion a beautiful variety of the red fir named Shasta fir may be studied. The finest variety of rainbow trout is native to the McCloud River, and in the same stream live the only Dolly Varden trout existing in California.

Seventy-five miles southeast of Mount Shasta stands another volcanic cone, Mount Lassen. This flattened cone rises 2,000 feet from a plateau, reaching an elevation of 10,577 feet, and like Shasta is composed of lava and ashes. Likewise it forms part of the spectacular lava formations that cover 150,000 square miles, occupying a portion of several neighboring states. On the ridge to the north rise a number of smaller volcanic cones.

Members of the Arguello exploring expedition were apparently the first white men to view this peak. They named it Mount San José. In the late forties it was dubbed Lassen Buttes after Peter Lassen, a pioneer who was held prisoner on its slopes for many days during a severe snowstorm. The mountain is easily climbed and now furnishes thrills to the climber because of the uncertainty as to possible eruptions. In the summer of 1914 Mount

Lassen won the title of "only active volcano in the United States south of Alaska."

Shasta and Lassen are monuments left to remind us of a past geologic age when numerous volcanoes covering four northwestern states belched forth lava and left behind one of the largest of the lava fields on the continent. Having spent their fury, they have lain dormant for many years. Lassen alone has provided fireworks for present-day human beings.

Tallac and Pyramid peaks in the Tahoe region draw many a mountain climber, but one finds no 13,000-foot peaks until the Yosemite region is reached. Clustered near each other are Dana, reddish in color, flanking the Tioga Pass, McClure and Lyell, with their living glaciers, Ritter, Banner and the Minarettes, known for their beauty, and from there southward peaks too numerous to mention.

The Sierra culminates in Mount Whitney, 14,501 feet, highest mountain peak in the United States outside of Alaska. From the west, its climbable side, it gives a broad shovel-shaped front thickly studded with granite spires. A distant view from the south gives the mountain a helmet-shaped crest because of the escarpment along its eastern face. When one gains the top, a stone building erected by the Smithsonian Institute to shelter its staff of scientists, is found. From the summit one looks into the Owens Valley and its lake nearly two miles straight down. Lone Pine is but five miles away although one may have journeyed nearly four times that far by trail from the same point. White salty bottoms of lakes dot the desert country. Just beyond one looks down into Death Valley, over 200 feet below sea level. Here then is a real contrast. To the west across the deep cañon of the Kern River is the serrated divide separating the two great watersheds of the Kings

and Kaweah rivers. Northward range other peaks nearly as high, with Mount Tyndall but six miles away.

We must not miss the southern end of this mountain chain. Guarding each side of a low pass, used for more than three quarters of a century, stand two peaks, the one on the north, San Gorgonio (11,485 feet), the one on the south, San Jacinto (10,805 feet), both graced with original Spanish names. From the east their walls rise abruptly from the desert. On the west, wooded cañons and valleys and alpine meadows entice the vacationist, and the white granite peaks tower above. Mount San Jacinto, "noblest mountain in the south," is reputed to be the steepest mountain for its height on the continent. A ten thousand foot climb (2 miles) straight up from the desert puts one among snow banks. Probably this is the highest stone wall in the world. From the summit one looks directly down at the desert, the Salton Sea and palm-grown cañons, while westward is a checkerboard of orchard and town, with the Pacific and its islands dim in the distance. Mount Whitney is visible to the north on clear days. The ridges to the south continue to Mexico.

In the San Gabriels, Mount San Antonio (10,080 feet), of white granite, is less high but furnishes a splendid view of desert and ocean. It is so easily accessible and so popular as to be avoided by the seasoned mountaineer.

Granite-Walled Cañons

Herbert W. Gleason, world traveler and well-known photographer, has labeled the Grand Cañon of the Tuolumne River one of the finest displays of scenic grandeur within the limits of the United States in the following words: "I unhesitatingly affirm that the Grand Cañon of the Tuolumne River deserves to rank, in its sublime impressiveness, stupendous majesty, and rugged beauty with anything this country affords. The Grand Cañon of the

Colorado is, of course, superior in its vast extent and its brilliant coloring; yet the Tuolumne Cañon, by reason of the fact that its perpendicular walls, 4,500 to 5,000 feet in height, are as a rule less than a mile apart at their base, while the walls of the Colorado Cañon are from ten to fifteen miles apart, produces a sense of overwhelming grandeur which not even the great Arizona Cañon can give. Through the length of the cañon for twenty miles flows the Tuolumne River in a constant succession of magnificent waterfalls and cascades, some of which, though not as lofty, are more uniquely beautiful than the famous falls of the Yosemite Valley."

For many years the Tuolumne Cañon was believed inaccessible because of statements by Whitney in the reports of the Geological Survey of California. John Muir negotiated it during low water and afterwards various members of the Sierra Club climbed it. A good government trail was finally constructed to the Waterwheel Falls from Soda Springs and this has now been continued through Muir Gorge to Pate Valley. The trip either up or down the cañon via this trail is one of the finest that awaits the Sierran tramper.

The region of highest peaks, and in some respects the grandest part of the Sierra, is to be found at the heads of the San Joaquin, Kings and Kern rivers. A series of peaks towering 14,000 feet form the background for three mighty cañons. No roads cross the Sierra in this region and access is possible only with pack train or knapsack.

Like most of the larger rivers the San Joaquin has two forks near its source. At the head of the South Fork are found the finest peaks the Sierra affords. They are so formidable that no pass less than 11,400 feet is to be found.

The Middle Fork of the Kings River finds its source in the same group which feeds the South Fork of the San Joaquin, and the South Fork of the Kings drains another

rugged set of 14,000-foot peaks. The cañon of the Middle Fork contains a notable valley comparable to Yosemite, known as the Tehipite Valley. It has its domes and waterfalls, one of them 3,700 feet above the floor. Just below this valley the cañon is 7,000 feet deep. The cañon of the South Fork, usually called Kings River Cañon, is likewise Yosemitic in character but of lesser magnitude, lacking waterfalls and meadows. The cañon of the Kings is a favorite camping place of lovers of the high Sierra.

John Muir's description of the more notable cañon is better than I can give:

"Tehipite Valley on the middle fork of Kings River is about three miles long, half a mile wide, and the walls are from 3,500 to nearly 4,000 feet in height. The level floor is planted with oaks and pines, libocedrus, etc., forming charming flowery groves like those of Hetch Hetchy and Yosemite, enclosed by majestic granite walls which in height and beauty and variety of architecture are hardly surpassed by any other Yosemite in the Sierra. Several small cascades coming from a great height sing and shine among the intricate architecture of the south wall, one of which when seen in front, seems to be a nearly continuous fall about 2,000 feet high. But the grand fall of the valley is on the north side, made by Crown Creek, a stream about the size of Yosemite Creek. This is the Tehipite Fall, about 1,800 feet high. The upper portion is interrupted by dashing cascades but the last plunge is made over a sheer precipice about 400 feet in height into a beautiful pool in a recess of the valley floor. To the eastward of the fall is the great Tehipite Dome, a gigantic round-topped tower about 2,000 feet in height, the most striking and wonderful feature of the valley, and one of the most wonderful of all the famous domes of the Sierra."

Most people are agreed that Tehipite in grandeur is well short of Yosemite, this better known cañon excelling all

others in its perpendicular walls, massive domes and high waterfalls. However, to many, the Tehipite will continue to appeal even though a lesser Yosemite, because isolated and free from crowds.

From Tehipite one may gain the Kings River Cañon on the south fork of the river, by way of Granite Pass, passing through wonderful glacial cirques and dropping down Copper Creek. To the visitor this cañon has extraordinary charm. Lacking the wild exuberance of Tehipite, it appears more peaceful. The river is less turbulent, the valley broader, the Grand Sentinel a lesser dome; its forested floor is more extensive. More easily accessible, this cañon already has its resorts and consequently will be better known.

Both the Tehipite Valley and the South Fork Cañon are Meccas for mountaineering clubs and the hardier mountain lovers. Words are ineffective. One must see the Kings River country to understand it and appreciate it.

The vastness and stillness of the Sierra are noteworthy, particularly to those dwelling in the city where noise is omnipresent. Standing out above the calls and songs of birds is the sound of running water, with the rustle of leaves taking second place. Too seldom does the visitor in the Sierra note the pleasing sounds that come from running water. The lines that led me to listen are the following, taken from Ellen Burns Sherman's "The Manuscripts of God":

"Continuing her modulations from the songs of the meadow grasses, nature passes to the rustling cadences of the cornfield, where she not only fills the ear with never-to-be-forgotten melodies, but casts her spell over the other senses as well. Waving her invisible baton, she sets all the purple-tasseled heads bowing to each other, in stately minuet, while the rustling of the long, dry leaves carries out the illusion of the rhythmic flutter of silken petti-

coats. This is only a beginning of nature's improvisations on what might be called her dry scales.

"Still deeper and sweeter are the harmonies which she evokes from her liquid measures. In the pattering rain, which is really only a liquid transposition of the lullaby of the leaves, she sings us a cradle-song; in the rill, a simple folk-song; in the brook, a slightly fuller melody; in the river, a four-part hymn with chorus; in the waterfall, a solemn chant; in the cataract, a glorious magnificat; while in the ocean tides and breakers she gives us her masterpiece, for whose orchestral performance she engages the leadership of the moon."

Nowadays we put on one sense, eyesight, most of the work that should fall on the five different senses. The ears are fully as capable of giving pleasure as the eyes, as is evident when we enjoy music. Yet the average person in the out-of-doors does not attune his ears to sound, though he may use his eyes. Findings of the ear are worth while. Sounds may not only give pleasure but they may be helpful in the discovery and identification of many forms of life. A quick ear may help a bird student more than a good eye. Colors are deceiving. A trained ear is dependable because it catches pitch, rhythm and tone quality in a bird's song. If one varies from the rule there are still other features that help in naming the singer.

The Kern River Basin heads at Mount Whitney and companion peaks. Ranged alongside of Mount Whitney are four other peaks surpassing the 14,000 foot level. Closest are Mount Williamson, massive, steep and jagged, and Mount Tyndall, made famous by Clarence King's account of its first ascent. The Kern River is walled in for a longer distance than other Sierran streams and has many features that draw the mountaineer. Geologically it is distinctive, for the Kern River Cañon is the only one of the Yosemite-like cañons that does not run westward, but parallels the

faulting along the east face of the range. For thirty miles the Upper Kern has so few turns in it that one may find points of vantage that give a view of this entire sweep of rugged cañon, with its flowery meadows and extensive forest. Beautiful waterfalls drop over its walls and colored rocks add to the beauty of the cliffs. Of but little less magnitude than the main crest of the Sierra at this point are the two great divides that separate the cañon from the Kings River Basin and from the Kaweah Basin. The Kings-Kern divide Clarence King described as "a great mural ridge watched over by two dominant heights, Kaweah Peak and Mount Brewer, its wonderful profile defining against the western sky a multitude of peaks and spires. Bold buttresses jut out through fields of ice, and reach down stone arms among snow and debris."

Lakes and Meadows

Lake Tahoe, the largest high mountain lake in North America and second highest large lake in the world, 21.6 miles long and 12 miles wide at its extreme width, lies in a depression between two ridges in the summit region of the Sierra. The peaks on both sides reach an altitude of 8,000 to 10,000 feet. The peaks to the west are more rugged and precipitous, but no less high than those that top the more gentle slope to the eastern crest. The lake lies at an elevation of 6,225 feet. The highest peak on the west side, Mt. Tallac, towers 3,550 feet above the lake. Next to Crater Lake in Oregon, Lake Tahoe is the deepest lake in America; one sounding being 1,645 feet. Because of this great depth the lake never freezes over no matter how cold a winter may be. Depth is responsible also for the magnificent blue color of its water. Shallower water gives a green tinge. The water is so clear that one may see bottom in over a hundred feet.

Geologists explain this large, deep, beautifully-colored

lake as a filled-in depression caused by two faults along flanking ranges. As the depression filled in with water it overflowed to the north, cutting the Truckee River cañon and lowering the lake's surface. There followed sizable lava flows which blocked the cañon and raised the level of the lake. Meantime an accumulation of snow caused glaciers to erode the surrounding mountains, leaving extensive morainal deposits, as those about Tallac and Emerald Bay. Water erosion that followed has left the present configuration.

Lake Tahoe first became known through its accidental discovery by Frémont on February 14, 1844, while he was traveling south through Nevada seeking a pass which could be crossed. Winter snows had impeded his progress in the chosen direction. A month previous he had found and named Pyramid Lake and a few days later the Truckee River. After continuing southward as far as what is now Bridgeport, Mono County, without finding a suitable crossing, he turned northward through Markleville to Faith and Hope valleys. Ascending a nearby peak, Lake Tahoe lay before him. The discovery was followed by a fateful crossing of the Sierra via Carson Pass and the final arrival at Fort Sutter. The difficulties encountered are indicated by the fact that thirty-four out of sixty-seven horses and mules, including the mule that carried a valuable collection of plants, were lost.

In more recent years the lake has become a favorite resort for summer vacationists. Attractive fishing and bathing as well as the beauty of this deep blue mountain lake and its surroundings combine to give it popularity. Its shores are lined with resorts, summer homes and camp grounds.

From many a high peak in the Sierra twenty or more glacial lakes may be seen. In most instances one must clamber over several moraines of rock to reach them. En-

circling perpendicular walls rise at the back and snow banks feed many little streams that trickle into the lakes. The view from above is entrancing as one looks over a thousand-foot precipice to the rounded blue lake below, guarded by granite walls and with a rock barrier at its lower end. Each traveller in the High Sierra has his favorite lake. He may chose one or a group. One dare not say that Tilden, or Tenaya, or Merced Lake, in Yosemite National Park, is more beautiful than Garnet Lake, or Shadow Lake, at the head of the San Joaquin, or than the Rae Lakes, Sixty Lake Basin, Bullfrog Lake or the lakes of the Evolution Group.

Glacial lakes of past centuries are now meadows, owing to nature's filling process. The largest meadows of the Sierra are those described thus by John Muir:

"The Big Tuolumne Meadows are flowery lawns, lying along the South Fork of the Tuolumne River at a height of 8,500 to 9,000 feet above the sea, partially separated by forest and bars of glaciated granite. Here the mountains seem to have been cleared away and set back so that wide open views may be had in every direction. The upper end of the series lies at the base of Mt. Lyell, the lower below the east end of the Hoffman Range, so the length must be ten or twelve miles. They vary in width from a quarter of a mile to perhaps three quarters, and a good many branch meadows put out along the banks of the tributary streams. This is the most spacious and delightful high pleasure ground I have yet seen. The air is keen and bracing, yet warm during the day, and though lying high in the sky the surrounding mountains are so much higher one feels protected as if in a grand hall. Mts. Dana and Gibbs, massive red mountains perhaps 13,000 feet high or more, bound the view on the east, the Cathedral and Unicorn peaks with many nameless peaks on the south, the Hoffman Range on the west, and a number of peaks

unnamed, as far as I know, on the north. The grass of the meadows is mostly fine and silky, with exceedingly slender leaves, making a close sod above which the panicles of minute purple flowers seem to float in airy, misty lightness, while the sod is enriched with at least three species of gentian, and as many or more of orthocarpus, potentilla, ivesia, solidago, pentstemon, with their gay colors—purple, blue, yellow and red—all of which I may know better ere long."

To many people other mountain meadows are equally beautiful. Simpson and Grouse meadows in the Kings watershed are often termed the most beautiful in the Sierra from the standpoint of wild flowers. To many old-timers, however, it may be a tiny meadow perched on some great wall that has left the most lasting picture.

To know these mountain peaks, cañons and meadows intimately one must travel Sierran trails. Motor cars and roads must be left far behind. Nor must one expect that map elevations indicate the maximum climb. Ridges must be crossed, with cañons between that mean a loss of much of the elevation gained. But the views from the ridges, the trout in the streams, the quiet magnificence of a glacial cirque and the cold water from a trail-side spring compensate for and obliterate the memories of perspiring brow and aching muscle.

John C. Van Dyke's tribute to mountains should find a place here: "We change our point of view but the mountains themselves change not. Whatever face they turn to us, whatever their appearance, it is always one of beauty. They are mere breaks in the crust—crushings of the earth-shell—and by the same reckoning color is a mere break in the beam of light, but what a wonder work each of them spreads before us! We pick and choose here and there—some for the strength of form and others for the glory of color—but nature herself makes no choice and

has no preference. For she formed and garbed and hued each manifestation from the first gentle heave of a foothill to the last sunflash of a pinnacled peak, with a singular care and endowed it with a peculiar and superlative beauty. Each after its kind was made perfect and complete within itself."

Those who have written about the Sierra have extolled its cañons, its cliffs, its peaks and its forests, but not half has been told of the varied life that makes it more than a mass of rock.

One of the most interesting figures in any western state is the bewhiskered prospector with his lone burro traveling through the unfrequented mountain districts, ever on the search for gold. The prospector knows what he is searching for and he is ever on the alert to find precious metal. Gold, however, is not the only precious thing to be found in mountain districts. In fact, living things should be of more interest and should develop enthusiasm far more than inanimate gold. Few people are wise enough before going on their summer vacation to choose some special objects or subjects which will be the goal of their explorations, and thus allow themselves to become prospectors. Every one should know some of the nuggets of nature for which to search, so that he may experience that thrill which comes with discovery, the thing which forces the prospector to keep on searching incessantly. Furthermore, he should be a real explorer, attempting to find the new things in nature and to make a scientific report thereon. If he lacks enthusiasm for the life of an explorer, let him read any of the reports of the early exploring expeditions in the West.

Animal Life

The mountain district of California is rich in plant and animal life, owing to the diversity of climatic and physical

conditions. The vertebrate life alone probably cannot be matched anywhere in an equal area. Scientists of the University of California Museum of Vertebrate Zoology, in making a cross section of the Yosemite region, found 231 kinds of birds, 97 kinds of mammals, 22 snakes and lizards and 12 kinds of toads, frogs and salamanders. At least 7 kinds of fish are known from the same region. Should we limit ourselves to the yellow pine belt or to the red fir belt the number of birds and mammals would be quartered or even more reduced. Some forms are met also in the lowlands, others, because less conspicuous, fail to catch one's interest. In attempting to acquaint my readers with the Sierra Nevada and its life I must make choices from a rich array of plants and animals. I have done my best to select typical forms that catch the eye and ear of the mountain visitor and that awaken his interest because of form, color or historic background.

Those who have read John Muir cannot fail to have a word picture of Muir's favorite bird, the water ouzel. This author who could record his observations so delightfully says: "Among all the countless waterfalls I have met in the course of ten years' exploration in the Sierra, whether among the icy peaks, or warm foothills, or in the profound yosemitic cañons of the middle region, not one was found without its ouzel. No cañon is too cold for this little bird, none too lonely, provided it be rich in falling water. Find a fall, or cascade, or rushing rapid, anywhere upon a clear stream, and there you will surely find its complementary ouzel, flitting about in the spray, diving in foaming eddies, whirling like a leaf among beaten foam bells; ever vigorous and enthusiastic, yet self-contained, and neither seeking nor shunning your company.

"If disturbed while dipping about in the margin shallows, he either sets off with a rapid whirr to some other feeding-ground up or down the stream, or alights on some

half-submerged rock or snag out in the current, and immediately begins to nod and curtsey like a wren, turning his head from side to side with many odd dainty movements that never fail to fix the attention of the observer.

"He is the mountain streams' own darling, the humming bird of blooming waters, loving rocky ripple slopes and sheets of foam as a bee loves flowers, as a lark loves sunshine and meadows. Among all the mountain birds none has cheered me so much in my lonely wanderings—none so unfailingly. For both in winter and summer he sings, sweetly, cheerily, independent alike of sunshine and of love, requiring no other inspiration than the stream on which he dwells. While water sings, so must he, in heat or cold, calm or storm, ever attuning his voice in sure accord; low in the drought of summer and the drought of winter, but never silent."

The water ouzel, although a fairly common bird along mountain streams, cannot be discovered at will. Even in summer when birds hold to one locality, pairs are scattered. At least three pairs nest on the floor of Yosemite Valley and yet people sent to find them often return without attaining success. A friend of mine who spent several weeks every summer in the Sierra followed the suggestion of friends, going to the places where ouzels had been seen, yet despite her ambition she failed to locate a bird in four years' time. Of course, you are likely to be more fortunate, yet I say, a bird student cannot always produce an ouzel for study on request.

The observation that a white flash is visible as a water ouzel winks its eye stirred up a controversy among scientists which took several years to settle. Poetry such as this should stir even scientists to action:

"To watch a water ouzel wink
Is more of a job than you would think.
He dips his tail and bats his eye
And lets his nictitating membrane fly."

One group of scientists maintained that a well-developed nictitating membrane (the white one at the inner corner of a chicken's eye as it goes to sleep) furnished the white flash. Another group, discovering that the upper eyelid has a white margin, claimed that the winking of the eyelid was responsible. Finally Dr. A. H. Cordier, making observations at a distance of less than four feet and securing motion pictures which actually showed the white flash on five successive frames, indicated that this bird has a white nictitating membrane which moves downward, from the inner corner, from under the upper lid. This movement is different from that of most birds where the membrane is seen to move outward from the inner corner of the eye. In the water ouzel this membrane may be useful as an instrument to clear the eyeball of watery mist while near spray. The more the bird is subjected to spray, a common accompaniment of its life about waterfalls, the more often does it flash its nictitating membrane and clear its eye.

Seeing a water ouzel dive to the bottom of a six-foot pool, using wings and unwebbed feet, and pick from the rocks caddis fly larvae, one is led to understand a certain foundation for the old legend that credits the bird with walking on the bottom. It takes real exertion for the bird to maintain itself beneath water, especially if it stays half a minute, and when the object is accomplished it bobs to the surface like a cork. It may dive into the water from flight or rise from underneath and fly from the surface, but most of its diving is done from a rock or log. Caterpillars and larvae of aquatic insects form the principal items of diet but an occasional small trout falls prey to this oddity in bird life. A land bird, as indicated by unwebbed feet, the ouzel has adapted itself to an unoccupied, unfrequented niche in nature, and taken on aquatic habits and even oily down feathers to protect itself from

its watery environment. Yet its adaptation is certainly one of long standing, for young birds vie with a duck in the way they "take to water." Some fledglings I chased from a nest on a tributary of the upper Yuba River dove deeply as they struck the water of a large pool at the base of a waterfall and, using wings and feet, swam for some distance under the water before climbing out on the bank to preen themselves. Thus early do they demonstrate their interest and ability in water. Do not miss acquaintance with the water ouzel!

How can a bird find a food supply about a wind-swept mountain peak? Yet inspection will show that snow banks furnish a cold storage larder. Insects and seeds are continually disclosed and a bird, the rosy finch, has found this out. Stomach examinations made by the government have shown more than ninety per cent of the food of adult birds to be made up of seeds. As might be expected, the young are fed more largely on insects.

This bird is forced to be late in nesting, and young are seldom about until late in summer. The rosy finch is usually the sole inhabitant of the snow-covered summits. Although occupying a most out-of-the-way place in nature this bird may yet gain advantage through lack of competition and in abundance of open space in which to play and work.

For a sparrow, the Sierra Nevada rosy finch or leucosticte has large and comparatively sharp-pointed wings, making it a remarkably good flier. Doubtless such developments of wing are necessary to withstand the windy situation where the bird makes its home. The rosy finch seems to fly directly into the wind with little effort. Furthermore, this bird appears to appreciate its winged supremacy so much that it often seems to dash about just for the enjoyment of flying. At least it is difficult to

explain otherwise the numerous flights not connected with food getting.

Although the gray-crowned rosy finch was first described in 1831, its nesting habits were long a mystery. After several attempts to locate a nest and eggs, and after two 120-mile trips to Pyramid Peak, near Lake Tahoe, and back, a California man, Milton S. Ray, secured specimens and photographs on June 21, 1910. Secreted among rocks near the summit reposed four white eggs in a bed of feathers.

Another Alpine bird is the California pine grosbeak, a bird that is never seen much below the timber line belt of trees even in winter. The male with his red head, breast and rump is striking in appearance. The females and young are plainly garbed in gray with yellowish head and rump. One may be fairly sure of discovering rosy finches on mountain summits, but a search for the pine grosbeak at timber line may be disappointing. When willow seeds and those of other plants are not available, because covered with snow, pine grosbeaks feed on the bud tips of pines, firs and hemlocks.

The pine grosbeak was another bird that long escaped the collector of birds' eggs. Seven years of endeavor in El Dorado County, searching the forested ridges still deep in snow, finally brought success to the same man who found the first rosy finch's nest. The never-before-discovered nest in California was finally located June 18, 1912, in a hemlock tree. Another nest was discovered the next day. The three eggs were found to be richly colored, with a wreath of black and deep brown spots around the larger end on a blue background. Historical interest always centers in the first set of eggs taken of each species and consequently it is termed a type set.

No one can be long in the Sierra Nevada without noting a peculiar bird song. Many compare the note with the

words "O dearie," the first being higher in pitch than the second two syllables. The song may be rendered by four notes: "tee-tee, too-too." The notes are easily imitated with a whistle. Few there are that recognize this as the song of the mountain chickadee. The wheezy "chic-a-dee-dee" given as a call is so different in tone quality that it is no wonder the real song is not connected with the chickadee. Follow up this song or the well-known call and one finds a typical chickadee with black cap and throat and white cheeks contrasting with the plain gray body. Few birds are so incessantly active in pursuit of food. During nesting time there is good reason for lively foraging for there are often seven mouths to feed in the old woodpecker's hole. One of these birds in Yosemite chose the safety of an iron vault afforded by the fire box of an iron range, entering and leaving through one of the draft holes in front. Need to use the stove led to discovery, and to sufferance of the cold by the ranger, who did not care to disturb the occupants.

Another bird more often heard than seen in thick forest is the red-breasted nuthatch, whose little nasal "*yank-yank*" is sometimes compared to a tin horn. An adept climber on the trunks of trees he appears to be as much at home going down as up, or on the underside of a limb as on top. Bobtailed, he does not even use his tail for a support as do the creeper and the woodpeckers. This dweller in the tree tops gleans insects and insect eggs from the topmost trunk and limbs, and even builds his nest high above the ground. If you would know him use your ears!

Two other nuthatches are to be found; one, the largest of the three, has a white breast and white cheeks, the other, the smallest, is plainly garbed. The slender-billed and pygmy nuthatches have call notes quite different from the nasal one-syllabled note of the red-breasted.

Our best singers boast of their range between high and

low notes. The range in pitch shown by the dotted cañon wren should make it a prima donna among birds. Among granite walled cañons one hears a loud clear whistled song starting high and cascading down with a series of slurred notes, gaining in speed to the abrupt end. When close, the song is heard to end with some typical wren-like notes. Few bird songs are as thrilling to the ear. Printed words cannot convey an idea of this delightful songster that uses the sounding board provided by a granite wall of rock and the accompaniment of the glorious tones of a waterfall. Find the singer as he clings to a rocky wall and then flies to a higher ledge and you will note the upturned tail and characteristic manner of a wren. The white throat and chestnut underparts are striking but the dots on the grayish back are not so noticeable. The nest is usually placed in a crevice in the rock and almost invariably is of matted animal hair. Suitable locations in buildings are sometimes appropriated for a nest site.

If the cañon wren has an imprint of its environment, it is in the rhythm of its song. Start a boulder bounding down the mountain side and listen, and you get in rhythm, if not in tone quality, the song of the cañon wren. Its call may be partially produced by striking two granite rocks together. Fanciful? Yes, but descriptive!

Conspicuous in the timber line region is a large bird with a crow-like call, often called Clark crow. Another name is applied, Clark nutcracker, and nutcracker he is when holding seeds of the white-barked pine with his feet and breaking them open with his bill. The scientific name *Nucifraga* means nut-eating. The bird deserves the prefix Clark because it was discovered and named by the famous Lewis and Clark expedition to the northwest in 1805-06. Some have adopted the name Frémont Crow utilizing the name of yet another early explorer. Overhead this conspicuous bird appears black in flight because

of the black of the under side of the wings which is contrasted with white patches. The outer tail feathers are also white. When the bird is perched it appears gray, the black wing feathers being largely concealed as the wing is folded. Gifted with a splendid wing spread, the nutcracker clears the intervening cañons with ease as he moves from one high ridge to another. Although not easy of close approach this bird cannot pass unnoticed because of its loud calls and distinctive plumage.

Though a resident about timber line the Clark Nutcracker occasionally appears at lower altitudes. At least once this bird appeared in numbers near the coast. In 1923 birds were common on the Monterey Peninsula. As with the rosy finch and pine grosbeak here is a bird of whose nesting habits little is known. A satisfactory account of the nesting habits is still awaited though a few sets of eggs taken in California are in collections. Apparently the nesting season is well advanced before snow leaves the ground. A nest containing fledged young was discovered on Sentinel Dome in Yosemite National Park by Donald Mc Lean the second week in June, 1927.

A bird with a notable migration route is the western tanager. However, his reputation is built largely on the basis of bright plumage. Neither the call note *per-tit* nor the robin-like song makes it as conspicuous as the bright red head, yellow breast and black wings of the male. The female and young are greenish yellow and lack the bright red of the male. This, the brightest colored inhabitant of pine and fir forests, spends the winter season in Central America. Its spring return to California via the Colorado Desert and mountain passes of southeastern California is heralded in the newspapers with some such statement as the following: "Banning, Calif., April 26. Large numbers of brilliantly colored tropical birds have been seen in this vicinity the past few days. They feed about in the orchards

and are seen everywhere. Nobody as yet has been able to identify them." In this fashion are those who know birds informed of the northward migration of the western tanager.

Many tanagers stop and make their summer home in the mountains of California but many others proceed northward and a few even cross two mountain ranges in Canada and nest along the eastern flank of the Rockies. An explanation of the roundabout route instead of the one used by many birds that follow up the eastern flank of the Rockies from Mexico is yet to be found.

The smallest bird in the United States is a summer resident in the mountains—the Calliope humming bird, named for a Greek goddess and not for the steam whistle instrument that follows a circus. The wholly green back, small size and the lance-like lavender feathers of the gorget help one to distinguish this from the other humming birds. Winter finds this bird in southern Mexico. While the females rear their twins in a nest in a lodgepole pine or black oak, the males occupy a perch on a dead twig or forage among the wild flower gardens. In courting display, the Calliope male poises and lowers his position a number of times, rather than making the pendulum swing and high dive of the rufous. This is the only nesting species of humming bird in the higher mountains, although the rufous humming bird is a common migrant in mountain meadows in August and September. The rufous, the common nesting bird of the northwest, goes north through the valleys of California but southward along the crest of the Sierra where flowers still bloom and insects are available.

Insects

The insect world is a vast one and there is no end to the fascinating life stories attached thereto. Butterflies catch the eye, but not many are distinctly mountain forms. There

are three or four kinds of swallowtails, the ever present monarch and mourning cloak. To these the mountaineer adds California sister, Lorquin's admiral, plenty of azure blues about the wet places, and the sulphurs and pine whites. Around the peaks the black swallowtail is sometimes found. At night around the light, one may have a chance to admire some large moth, like the sheep moth, pandora or ceanothus moth.

The commonest beetle is always the abundant reddish-colored ladybird beetle. Ladybird beetles swarm together in fall and hibernate over winter. At times they are so abundant as to be obnoxious to the camper and swarms are so massed that one could fill a flour sack. The State Department of Agriculture at one time collected these beetles in the mountains by pack train and when melon growers in the Imperial Valley complained of aphis destroying their cantaloupes, ladybird beetles were sent by the million and liberated in the fields to help control the pest.

Other beetles are conspicuous because of size although not so abundant. Along in June the ten-lined June beetle begins to appear. Its size and buzzy flight often frighten those unfamiliar with it. After noting the ten light stripes on the wing covers, one becomes interested in the antennae which open and close like the leaves of a book.

When boys find a fine large long-horned beetle (*Prionus*), they are tempted to hold it to the ear of an enemy and let it take hold. This large beetle, the adult of a large borer, has real jaws and it can pinch. When crawling on the ground it looks as large as a small rodent and if one bumps into you in the dark you know "something hit you." The wood-eating larvae of this beetle tunnel through dead wood and form the main food supply of the largest of our woodpeckers—the pileated.

About every camp ground in the mountains there is to

be found an old decayed log. Observe it closely! It may contain no end of galleries or tunnels made by termites or white ants. Though quite different structurally from true ants, their social life includes queens, kings, workers and other castes. After several generations of wingless forms these eaters of wood produce winged sexual forms that migrate. A log near my camp turned out hundreds of winged termites every evening at the same hour. The ground and air roundabout seethed with crawling and flying termites. The wings break off easily and if one of the white ants is disturbed it often reaches back and bites off its wings. These winged forms lay eggs and start other colonies in dead wood. Those that do not hide soon enough furnish food for birds. I have seen robins stand on a log and catch the winged termites as they swarmed out.

Native species of termites help to turn decayed wood back into soil. Foreign species attack houses and furniture leaving the outside shell and consequently little external evidence of their work. Two or three cities in Southern California are having a continuous fight with termites. This is a difficult insect to control.

Mammals

Who can make a living from a rock pile? Convicts are supposed to earn bread and butter from them, but who would choose such an abode for a permanent home? Yet a small mammal, rat-like in appearance, has chosen the most typical of rock piles as a permanent abode. Furthermore, this mammal chooses only those rock piles of high elevation that are covered with 30 or 40 feet of snow every winter. Let me introduce the cony as this rock pile dweller. In the higher mountains nearly every pile of talus is inhabited, though visits to them fail to disclose the inhabitants. A fisherman making his way around a glacial lake crosses the pile of rock at the foot of the

towering cliff behind the lake and notes a high-pitched, two-syllabled *check-ick*. Seldom does he see the noise-maker.

Once while collecting for a museum, I was told about conies that dwelt in the rocks and was asked to secure some specimens. I sat in the midst of a tumble of rocks patiently awaiting an opportunity. Off in the distance I spied a slight movement on a rock and there was a distant squeak like a rusty gate. I fired, but found my animal was out of range. Another hour's wait. I looked again at the rock opposite, one six feet away and a little gray animal hopping along like a rabbit disappeared in a crevice before I had time to raise my gun. Another half hour's wait. On a rock to my left I spied my quarry, blazed away, and picked up a few fragment of a cony. Too close! I learned about them through endless patience and disappointment. "Is that the only cony you got in four hours' work?" I had to admit it was.

Mount Dana on the eastern edge of Yosemite National Park is 13,050 feet high. A crowd is descending from its summit after experiencing a never-to-be-forgotten storm. A golden eagle soars by. We occasionally see a cony disappear under a slab of slate. We feel that we ought to be able to find the hay piles we have read about. A runway leads under a slab of rock and when it is lifted there is the winter store of grass piled correctly and curing properly. It smells sweet. This particular supply contained much lupine as well as grass and sedge.

The cony is the haymaker of the talus. The moment we picture the home of the cony in winter we are not surprised at the forehanded garnering against winter shortage of food. Some mammals survive the period of stress by hibernating, but apparently the cony has good quarters in the interstices of the rocks during winter cold and only needs the food supply to be comfortable.

FAVER

To many a mountaineer the cony is a rock rabbit. Furthermore, there is the story that it is a cross between the rabbit and the rat. There are mannerisms that suggest this although far from scientific truth. Ears and general shape suggest a rat except that no tail is visible. The ears in reality are rounder and appear to point forward. In locomotion and mannerism and soft fur the cony is suggestive of a rabbit. The teeth also are more like those of a rabbit. It is given a distinct family name.

The squirrel family is well represented in the mountains. The common ground squirrel mounts to elevations of over 7,000 feet. Some seven species of chipmunks varying in size and color as well as habit are more or less altitudinally distributed. The dull colored ones of the foothills scurry away over rocks and through the bushes while the Tahoe chipmunk of higher elevations takes to trees at the first hint of danger, aptly utilizing its splendidly adapted claws and toes. Smallest and palest is the alpine chipmunk that may share your lunch with you on Cloud's Rest in Yosemite. Its whole body is but four inches long and the tail adds only another three. Rock crevices form its home and "agility saves his hide" from predators. That hardy plant with rosetted leaves and pinkish fuzzy flowers called pussypaws, appears to furnish a seasonable food supply.

"What is the large brown animal that we saw scurrying away to a hole in the rocks as we came across Tioga Pass?" is a much asked question. It is the largest member of the squirrel family, known as marmot, woodchuck or ground hog. In California the marmot is confined to the higher mountains. Its size, lumbering gait and loud whistle attract attention to it.

In the red fir belt of the mountains lives a reddish colored squirrel commonly known as a pine squirrel, or chickaree. This noisy little animal is an expert climber and he makes

wonderful broad jumps from one tree to another. His main occupation is that of cutting pine and fir cones. After climbing far up in the tree he gnaws off the cone and lets it drop to the ground. Then, coming down the side of the tree to the ground, he tugs the cone to some vantage point such as a log, or the foot of the tree, where, alert for enemies, he gnaws off each scale and gets the pine seeds behind it. Evidence of his work is to be seen in the great piles of scales and the core of the cone which he leaves behind. Read John Muir's account of this interesting animal in his "The Mountains of California."

Although every one is pleased with the bright colors and interesting actions of chipmunks there is no member of the squirrel family which is more attractive than the flying squirrel. As a rule this animal is but a name to the average person, for though fairly common in forested districts, it forages at night and consequently is seldom seen. Lumbermen report seeing flying squirrels sailing out of the top of a tree as it is felled, and bird students occasionally have the experience of driving one out in broad daylight from some old woodpecker hole in a stub. A few years ago nature guides in Yosemite were able to give a thrill to their students by disturbing a flying squirrel from his noonday siesta in such an old stub. Those who have tried keeping flying squirrels as pets have always considered them the very best.

It should be understood that a flying squirrel does not actually fly. It has no true wings nor is there any movement of the skin which gives a sufficient expanse of surface to support the animal in the air. In reality a flying squirrel volplanes from a point on one tree to a lower point on another tree.

Although the desert is the place to study reptiles, the Sierra has several conspicuous ones that must be mentioned. The garter snake, the "water snake" of the average

person, is found in the mountains, though it is often a spotted species, rather than the commoner striped form. Rattlesnakes rarely are found in the higher mountains though statements that they are entirely absent above elevations of six thousand feet are not accurate. In Mariposa and Madera counties they have been found occasionally at elevations of more than seven thousand feet.

The most striking snake of the mountains is the king snake with rings of red, black and white. The milk snake has but two colors, black and white. The bright colors of the king snake and the color pattern remind one of Indian beadwork. This is one of the few snakes of the state that bear favorable reputations. The story has persisted through the years that this snake seeks out rattlesnakes and captures and eats them. Many are the stories of humanly arranged combats between the two. However, scientists discount the story, although admitting that this constricting snake has cannibalistic habits. King snakes actually do eat other snakes and also rattlers, but they are not the "deadly enemy" of the poisonous rattlesnake that their reputation would lead you to believe. Nevertheless, this harmless snake has been properly favored and it deserves the protection accorded it by the average person.

The biologist finds proof that snakes once had legs whenever a member of the boa family is dissected, especially if the specimen be an embryo. One very interesting member of the boa family lives in the litter of pine forests. Two names, each descriptive, are given it: rubber snake (it is smooth; it stretches and creaks like rubber) and double-ended snake (its tail is about the same size as its head). When mature, it is olive green in color, lighter below; it is more beautiful when young, for then it has a coral pink color. Odorless, never offering to bite, and seemingly friendly, it makes the best of pets. Those who

have the chance readily handle it and find that snakes are not slimy detestable creatures but curious legless vertebrates with no eyelids and an interesting means of locomotion and of food getting. The hind legs of the rubber or double-ended snake are represented in a rudimentary state by small pits on each side of the vent.

Lizards scurry about the rocks. The one that raises and lowers himself on his forelegs and has blue patches beneath is known as the fence lizard or swift, and, to the boy, as the common "blue-bellied lizard." Second commonest is the alligator lizard with such poor pedal extremities that he has to push himself along and wriggle like a snake. Rarer, and conspicuous with stripes and a blue tail, is the skink. In the central Sierra is a fine large skink named for the region where found, the Yosemite skink, that lacks the stripes and bright blue tail but is nevertheless conspicuous with a red snout. The body is olive green. No matter what the color or how bizarre, no lizard found in California is poisonous. Most of them are distinctly beneficial in the destruction of injurious insects and all will give a real thrill to the nature lover who stops to study them.

Plant Life

John Muir says of the Sierran forests that here may be found the grandest forest trees, "the sequoia, king of conifers, the noble sugar and yellow pines, Douglas spruce, libocedrus, and the silver firs, each a giant of its kind, assembled together in one and the same forest, surpassing all other coniferous forests in the world, both in number of its species and in the size and beauty of its trees!" Books rather than chapters are needed to portray the forest trees of California!

To choose typical plants from the array supplied by the Sierra is difficult. Those who have studied the plant life

of this range conclude that it is a mixture of three elements: plants typical of the Mexican deserts, those characteristic of the lowlands, and certain arctic species which have found suitable homes on the mountain tops. The Yosemite region possesses more than 1,200 varieties, the Kings River region probably a like number. Out of this multiplicity, were I compelled to select flowering plants, I would choose snow plant, pitcher plant, carpenteria, cassiope and polemonium. The common wild flowers we will pass just as we pass them along the trail: groundsel, mountain daisy, larkspur and pussypaws. But we stop to examine and study a few chosen ones.

No plant in the Sierra catches the eye quicker than the snow plant (*Sarcodes sanguinea*). The Sierra claims this plant as her own and it deserves its reputation. So distinctive is it that it is described adequately to the uninitiated as a bright red plant shaped like an asparagus tip. Its name is misleading for it has no direct relation to snow. However, if you see it pushing up between snowbanks the contrast in color is sufficient to suggest its name. To classify it along with manzanita in the heath family seems ridiculous until one examines the flowers. Surely it is a degenerate for it has lost all of its green color and all of its leaves. It must be either a parasite or a saprophyte, for no plant without green color can manufacture its own food. Dig down to the bulbous root and you will find it imbedded in decaying wood and bark of some coniferous tree, which shows it to be a true saprophyte. Its dependence on a ready-made food supply necessitates growth in a coniferous forest and usually it is to be seen pushing its top through a litter of pine needles. Many have tried to grow it from seed but with no success. Nowhere is it abundant although it develops a good crop of seeds. Places marked do not always show a plant the following year although there seem to be several sprouts from the same

bulbous root of dying plants which appear to await a suitable time for showing themselves.

Because of its scarcity and popular favor the snow plant has received protection in national parks for many years. Even though the regulation against picking has been enforced it has largely disappeared from the floor of the Yosemite Valley where it was once fairly common. It needs protection at Tahoe and other localities in the Sierra for it is not a plant to stand much picking nor, on the other hand, one to be lost to mountain visitors.

One other plant of the pine forests resembles a snow plant. It grows taller, more slender, is less brightly colored and has a sticky stem. Pinedrops is a near relative of the snow plant and is likewise a saprophyte. The scientific name *Pterospora* means winged seed.

There are plants with carnivorous habits and one of them grows in the mountains of Northern California. The California pitcher plant, sometimes called calf's head (*Darlingtonia californica*) catches and apparently uses insects as food. The tube-like leaves are surmounted with a hood which is snake-like in appearance and decorated with two wing-like processes. It is these leaves rather than the purplish flowers that act as traps for insects. No wonder the lure is successful. An insect attracted by color and odor alights on the leaf. Exploration soon brings it to a trail of sweets which lead it inside. If it tries to escape there is difficulty in finding the darkened entrance below when a transparent dome is conspicuous above. The tube has downward pointing hairs which help to send it to the fluid below. When engulfed in the fluid the insect is digested. Insects so caught include ants, bees, wasps, moths, beetles, and even grasshoppers. Sometimes the bottom of the tube for an inch or two is filled with disintegrating insects and the resultant fetid odor is noticeable as soon as a bed of these plants is approached. The

pitcher plant has not been recorded south of the Feather River district, where in some places it grows in profusion in marshy situations in the yellow pine belt.

It is not often that a plant, after it has been discovered and named, becomes lost as a living plant and has to be rediscovered, yet this is the history of the carpenteria. It was probably on Frémont's third expedition that carpenteria was first collected, for the headwaters of the Kings River were visited on that trip. The specimen was named *Carpenteria californica* in 1852, by John Torrey, professor of botany in Columbia College, who thus honored his friend Dr. Carpenter, of Louisiana. Without proper labeling, telling where it was taken originally, no one succeeded in locating the shrub in its native habitat for many years after it became known to science. Even though nurserymen found a strange bush northeast of Fresno, gathered the seeds and distributed them widely among horticulturists in the later seventies, it was some time before the resulting plants were identified as the same shrub discovered so many years before by Frémont's expedition.

Carpenteria, a member of the Saxifrage family, is classified near the wild syringa or mock orange. The flowers are white in color with a yellow center and measure two to two and one half inches across. When in bloom no one could pass the bush without noting its beauty. It is no wonder that it has become a favorite garden flower. To see it growing in the wild one must go to eastern Fresno County. Travelers to General Grant National Park find it in bloom. Had it not been domesticated it would have been limited to the foothills of the Sierra between the San Joaquin and the Kings River at the lower border of the yellow pine belt. Sheep and cattle do not eat it and the plant seems to thrive within its limited area of distribution. There are other plants with limited distribution but

none that is more attractive to the eye nor with a more interesting history.

"No evangel among all the mountain plants speaks nature's love more plainly than the Cassiope." So said John Muir of a dainty white heather that he hunted long to find. Here is a flower saved for the favored few who gain the high mountain passes. Fringing the rocks about high mountain lakes and meadows is a heather with scale-like leaves and wonderfully white bell-shaped drooping flowers. The common purple heather (*Bryanthus*) is as beautiful as it is commonplace, but the white one is a rare treat, a never-to-be-forgotten mental treasure. I can quickly name the place where I saw it first, Tilden Lake, and other locations line up as I review the years. Cassiope furnishes a picture in your mental gallery that does not fade.

Another treasure is saved for the mountaineer, sky pilot (*Polemonium eximium*), well named, for it grows around high mountain peaks. It is to be found on Mt. Dana above the 12,500 foot contour, well above timber line. It grows among the rocks profusely. I first knew it from a picture in a well-known botany. I know it now from numerous personal contacts. Peculiar worm-like compound leaves are clustered at the base nearly hidden by numerous flowering stalks bearing clusters of deep blue flowers. They are glorious!

Other timber line flowers worth finding are rock-fringe and Sierra primrose.

Willows grow almost everywhere. Far above the last white-barked pine at timber line one may find the alpine willow. Dwarf of dwarfs, it raises its slender woody stems seldom more than a couple of inches above the surface of a dried snow pool and the comparatively gigantic catkins occasionally stand a little higher. The plant seems made up largely of a tangle of roots. With a short growing

season of only a few summer months this plant is able to carry on its life processes. Perhaps this alpine willow should be more properly discussed along with trees but with its tree-like characters largely obliterated and because it is a plant so generally encountered by the mountaineer it finds a place in this chapter.

To most people fungi are "toadstools" to be shunned as poisonous. However, in recent years a sufficient number have studied spore-bearing plants in botany courses to recognize the endless variety and boundless interest in these lower forms of plant life. Many fungi display coloring and forms that are most attractive to the eye. There are now clubs which devote their attention to the field study of these plants. Helpful pamphlets attempting to disclose characters useful in recognizing poisonous and non-poisonous species are obtainable both from the Federal Government and from agricultural experiment stations. After reading them one discovers that there is no simple and infallible rule and one sometimes must resort to the method of "taste and see." It is best to let alone those that are not "tested and true." Many people in California who have been careless in their choice of fungi used as food have suffered death. In more than one instance a whole family has been wiped out.

One rule seems to hold fairly true: "Puffballs are non-poisonous." When one kicks open a ripe puffball and a cloud of brown spores spread in every direction it does not look appetizing. Yet many a Sierra Club member has stored away a lasting memory of certain small puffballs fried in butter. These had been gathered in red fir forest at altitudes of around 8,000 feet. I, for one, have tasted no forest product that was more palatable.

For beauty of contour and sculpturing no Sierran fungus compares with the Sierra puffball (*Lycoperdum sculptum*), fairly common in pine forests at middle altitudes

and restricted to the Sierra. In size it is a giant, sometimes six or eight inches across the top. When pulled from the ground its short stalk-like base gives the plant a pear shape. The surface is beautifully sculptured with pyramidal projections which are sometimes an inch in diameter and stand a half inch high. The plate-like projections are well compared with the back of a turtle. The pyramids often flop over at the top as though built up with cake frosting. No other puffball in the Sierra attains such a large size or has such sculpturing. When mature the outside covering breaks in pieces and discloses the powdery mass of yellow spores. The Sierra puffball is found from the Tahoe region to the Kings River and perhaps has a still wider distribution. It is conspicuous enough to attract the attention of those who seldom do more than exclaim when they note the puff of yellowish smoke arising around their feet as they kick a ripe fungus in the woods.

Travel the trails that lead to the higher ridges, study the geologic features and make friends with wild life, and you will join Charlotte Sanderson, a member of a Sierra Club outing, in saying: "How under Heaven's dome shall he have words to express his own dumb sense of the grandeur of the mountains? How shall he say to the dwellers in the foothills anything of the rare exhilaration of mountain air, anything of the mystery of silent heights, anything of the thousand beauties that defy analysis? . . . Mutely he pays his tribute, but when he has once felt the charm of these things he returns to them again, and again, with an almost gypsy instinct."

Chapter V

CHAPTER V

Deserts Bare, But Populous

Not in vain these wastes of sand.—John C. Van Dyke.

MOST THINGS are either appreciated or are not appreciated by human kind. So it is with the desert. There is no consensus of favorable opinion nor united show of antipathy. The uninitiated appear to hate it; the explorer and the experienced love it.

In literature we continually gain the idea that the desert is unfriendly. Stories of persons left to die of thirst have done much to strengthen this idea. The stuffy atmosphere of a Pullman car on a summer day is not conducive to interest or appreciation of the beauty of the desert.

"Aye, it is a cruel place, the desert! Cruel, that is, to the body. It denies food to the hungry stomach, and withholds water from the parched lips. The hot sands burn the toiling feet, and there is no living thing which the hand may touch without being pricked or stung or lacerated or enmeshed. If one would shout there is no man to hear, and if one would run there is no whither. A cruel, cruel place is the desert, the abode of all discomfort. But who wants to be comfortable? Not the noble soul; for to be comfortable is to be oblivious, to be unaware of livingness, to be in so far forth unalive. No one can be exactly comfortable in the desert; so when he

is goaded and scorched and stung into a sufficient alertness, the noble soul knows that he is alive, and, living, he rejoices. Rejoicing, he rejoices with all that is alive, and chiefly with the living things of the desert." Thus has W. Leon Dawson philosophized.

But talk to the people who live on the desert and they will tell you that they love it; they love its stillness; its gorgeous sunsets; its clean, still air; its unique plants and animals. There seems to be a lure about the desert which holds many a settler year in and year out in a lonely cabin with no desire to return to settled areas.

I can imagine the boredom that would overtake passengers in a railroad train stranded by some break-down in the midst of the desert; yet every naturalist I know could make himself quite comfortable and could find endless entertainment near at hand; in fact, many would prefer such a situation any time to the contrasted one of a forced stop in the rainy regions of the north. The desert is botanically and zoologically rich. Forms are distinctive; they show strange adaptations and catch the fancy in many ways.

As one scientist has pointed out, in spite of its unsavory reputation, the desert was a stimulus for the earliest poetic and religious literature. Likewise it caught the interest of the scientist, for the desert is a place where "nature meets us with unusual frankness," and where "her wonders clamor to be understood."

With no forests to furnish the rustling of leaves and no streams to furnish the sound of rushing water, the desert is noted for its stillness. The open desert stretching away in every direction increases the idea of quietude. This, too, is one of the reasons for the usual feeling of mystery so often experienced.

The fascination of the desert appears to increase with years of experience, for prospectors and settlers become

more and more content with their lot. To them the desert simply means "a land where springs and water-holes are many miles apart and grass or other horse feed is very scanty or altogether lacking."

On the desert one must endure the heat of the day. With thoughts of the closing of the day, with its coolness and sunset colors, the calm stillness of the night, and glorious break of a new day, this is not difficult. These are worth enduring anything to gain, even though it be the torture of midday sun, heat, and dust.

California deserts are not all sand, nor is the Great American Desert one vast plain. Mountains are nearly always visible in the distance. Old shore lines and lake bottoms furnish the sand which the strong winds move continuously into undulating drifts. Barren rock is modified with the sand blast. Heavy erosion follows a rainstorm, leaving deep gullies.

Atmospheric conditions are distinctive. The air seems particularly clean and clear. One is deceived by distance. Nowhere are skies bluer. Sunlight is piercing; moonlight astoundingly brilliant. No words can describe the beauty of the sunsets. Dry air is largely responsible for these phenomena.

Wherever air is heated on great open expanses the illusion known as a mirage is to be expected. The mirage is explained on the basis of refracted light rays, due to layers of air of varying density. The usual mirage shows a body of water with trees or islands. The picture may fade or become more distinct. Van Dyke says the mirage is one of the desert's most charming features because of its strange light and its softly glowing opaline color.

Though rain falls seldom, when it does come there is often a heavy downpour. Cloud-bursts in the mountains furnish the water, which, unchecked because of sparse vegetation, rushes down the cañons and cuts deep gullies

in the loose sand. The great amount of sediment carried by such swollen streams forms extensive fan-shaped deposits at the mouths of the cañons.

Geologically the southwestern deserts had their beginning with an inland sea. Outlets becoming closed and the water evaporating, the bottom became exposed. Various shore lines can be traced on surrounding ranges. Where the accumulation of salts was not too great, vegetation extended its range from the Mexican plateau region where it had its origin, and animal life, following along, also adapted itself to the new conditions.

What nature has taken a million years to produce man modifies in a few years' time. In many places the desert is no more; irrigated farms have blotted from view the typical desert, the "land of little rain." The automobile whizzes one over stretches of road in a few hours that the pioneer took weeks to travel amid real hardship and privation. Like other desert dwellers, man has learned to adapt himself and succeed in the "land that God forgot." In addition, many sections are being developed as winter resorts. Even Death Valley, weird, mysterious, awesome and known everywhere as the "hottest and lowest spot in the United States," is becoming a national playground. This hundred-mile stretch of desolation is a winter land of enchantment reached by train and comfortable motor stages. Where a summer temperature of 130° is not uncommon, the winter climate is delightful.

So fast is the encroachment and modification that there is grave need for reserved areas that will provide a glimpse for future generations of the real desert which has fascinated both primitive and modern man and formed the basis of an extensive literature.

In terms of physical condition, the desert regions are not difficult to describe, for one need mention only scanty and erratic rainfall, low humidity and excessive evapora-

tion, high summer temperatures, high wind velocity and great contrasts in both temperature and humidity.

Really to picture the desert, its life and its conditions, to one who has never seen it, is a much more difficult contract. In this case, one must deal with such terms as competition, speed, and adaptation. A study of the life of such an area shows that all forms of animal life, not excepting man, are particularly resourceful.

Where the sun scorches and the sand drifts, where to man everything looks lonely and parched, the land shunned by most is yet a place teeming with life. Insects swarm, rodents honeycomb the soil with burrows, lizards scurry to shelter, and plant life is thrifty and persistent though scant. Competition is keen. Survivals are well adapted to conditions. Some plants conserve moisture by reduced leaf surface or by storage. Others defend themselves from foliage eaters with thorns. Likewise water conservation is practiced by vertebrate animals. Most animal life is built for speed and prefers coolness and darkness to the heat and sunlight. Night prowlers often outnumber the day prowlers. Van Dyke speaks of the insects of the desert as "flashes of life, pin-points of energy." Even the primitive desert peoples developed skill and cunning. In reality the desert is not barren; it is not a waste. Man's crops cannot grow unaided as well as in better watered areas, but life is to be found in abundance, life adapted to desert stresses of climate and to its arid surroundings.

The entire landscape is pale hued; the vegetation is pale green and gray and animal life possesses a bleached-out appearance. Humid areas furnish heavily pigmented forms; desert areas pale forms. This tendency to pale coloration is the only modification of wide-spread occurrence in desert mammals; structurally they are like those of less arid locations.

In Southern California two passes lead from San Bernardino to the two great deserts, one northward to the Mojave and the other eastward to the Colorado. After reaching the top of the grade in either case the change in plant life is as abrupt as between sections of a botanical garden. The pass northward leads through a cañon. As one goes through the broader San Gorgonio Pass, the San Bernardino Mountains rise to the northward and Mt. San Jacinto forms a ten thousand foot wall to the southward. One has left orange groves and apricot orchards behind and now encounters great stretches of sparse vegetation out of which stand such interesting plants as the various cacti, the mesquite and the desert flowers. In some of the eastward running cañons of the San Jacinto range three phases of vegetation are noticeable. Nearly to their mouths are found streams of water with cottonwoods, alders and willows and other sizable green trees typical of the mountains, some of them hung with grape-vines; then comes a group of Washington palms indicating transition to the gray, sparse vegetation which stretches away across the desert proper.

There is reason for this contrast in plant life. Vegetation familiar to us over most of the state had its origin in northern climes; the drought-resisting vegetation of the southwestern deserts had its origin on the great Mexican plateau, and after the glacial period spread northward. Desert vegetation did not come from the north temperate and boreal floras, but from another floral realm.

Desert plants have adapted themselves so that little water is necessary for subsistence. Rapid evaporation is avoided by reduced and thickened leaf surface or gummy secretion. As Van Dyke has said: "With spines, thorns, barbs, resins, varnishes and odorous smells, Nature has armed her desert own very effectively."

Few desert plants dare to have broad leaves, or to expose

their leaves directly to the sun, but usually tilt them at an angle so as to avoid catching direct sunlight. The root system is enlarged and capable of securing all available moisture. The network of roots is often more extensive than the branches above ground; furthermore many plants store moisture in reservoirs, sometimes above ground, sometimes below. Protection from browsing animals is obtained by thorns, disagreeable odor or taste. Conditions are so severe that plants not possessing protective devices perish. Seeds sprout quickly, the plants grow rapidly and mature early.

Plant Life of the Desert

The commonest tree on the Colorado Desert is the mesquite. And almost equally abundant is its near relative the screwbean, more tolerant of alkali, more thorny, and named because of the screw-like shape of the seedpod. These trees, American relatives of the acacias, so widely planted, furnish food and shelter for most of the higher vertebrate dwellers of the desert. The wide-spreading top and tangle of the low-lying limbs make an extensive thicket and desirable shade. The Gambel or desert quail seeks shelter and nesting sites within this shade, and the phainopepla, or silky flycatcher, conspicuous with crest and black and white coloration, is a sure accompaniment of nearly every clump. Here gathers the insect life that furnishes food for both bird and lizard. The seeds may be termed beans, for they furnish food for bird, mammal and the desert Indian, who grinds them into flour.

The largest of American palms, the California fan palm or Washington palm, *Washingtonia filifera*, much used in landscape gardening in southern counties, is a native of the Colorado Desert, where it is limited to various cañons at the eastern flank of the San Jacinto Mountains, and across the desert valley at the base of the San Bernardino and

Cottonwood mountains. Palm Springs Cañon has become a notable winter playground, and deservingly, for its towering cliffs and tempting stream of water add much to the scenery. The main attraction is the grove of palms, each with its tuft of fan-shaped, fluted leaves, four feet broad, at the top, and just below them a thatch-like "skirt" of dead leaves closely encircling the trunk. Many have cleaner trunks because the dead leaves have been burned. These palms reach a height of 80 to 100 feet and apparently attain an age of more than 200 years. Desert Indian tribes made good use of the palms. The leaves were used to thatch their huts and the fiber in them was used for rope and twine. The tough stems made excellent arrow wood. The white man should revere them as trees of ancient lineage and as a prized possession of but a small section of the United States.

The desert is noted for strange plants. Among the most curious is the ocatilla. From a main, heavy root and trunk, there rise twelve to twenty long tapering shoots ten to eighteen feet long, gaunt and twisted, and making a grotesque appearance. Annually these tall shoots are bedecked with beautiful red flowers. Green leaves follow the flowers, and the spiny mid-ribs of these leaves, left as a winter protection from browsing animals, furnish a cactus-like appearance. The sudden transformation from a dry, dead-looking plant to flaming red and then to vivid green is one of the marvels of the desert. Rain furnishes the necessary magic wand.

A tree which in the distance appears to be a cloud of smoke because of its dusky foliage was named by the Indians, smoke tree. It grows in desert water courses and has anything but a cloudy appearance when in bloom, for the blossoms are blue and abundant enough to color the whole landscape.

The palo verde, a Spanish name meaning green pole, is

well named, for it stands out among desert plants because of this character. The well-nigh leafless green trunk and branches give meaning to its name. Another Spanish name translated "shower of gold" fitly describes the early spring burst of yellow bloom on this tree. One giant of its kind is described by J. Smeaton Chase as being eight and a quarter feet in girth, the largest limb five feet around, and covering a space with a circumference of seventy yards. Few reach half this size.

The ironwood is a sturdy tree, with abundant foliage and exceedingly hard wood, but one with limited distribution. Just as there have been reasons for various names applied to various desert plants, so with the cat claw. The cat claw forces acquaintance. While one loosens its hooked thorns, other claws take hold. Chase says of it: "You will not go far on the desert without meeting the cat-claw, nor will you part without cursing it." The so-called desert willow grows in gravelly washes.

Most of the larger plants of the desert are subject to attack by mistletoe, and frequently carry great bundles of this parasitic plant.

On the Mojave Desert alone there are from twenty-five to thirty different kinds of cacti. The cholla breaks easily and starts anew when dropped by the victim of its barbed thorns. The barrel cactus acts as a drinking fountain on the desert for those who are able to open it. Many cacti have broadened branches like those of the tuna or prickly pear, and spines give protection from browsing animals. The flowers and fruit of cacti are usually brilliantly colored.

Along the eastern edge of the Colorado Desert near the Colorado River grows the giant of all cacti, the saguaro, sometimes fifty feet in height. Only a few stand to the west of the river; many are found to the east in Arizona. From the main trunk, fluted and covered with spines,

branch out a cluster of erect branches almost equal in size. The adjective grotesque is often used in describing them. Large white flowers ornament the saguaro in spring. Yet it has beauty of form; "its lines are as sinuous as those of a Moslem minaret, its flutings as perfect as those of a Doric column." In the larger trees, the Gila woodpecker drills its nesting cavity, and the smallest of American owls, the elf owl, utilizes the deserted nests of this woodpecker. This tiniest of owls is seldom seen, for it hunts its insect prey at night. A screech owl, another usurper of woodpecker holes in giant cactus, is called the saguaro screech owl. As might be expected from the number of rodents, the desert is well populated with owls of various species.

The creosote bush with small bright green wax-coated leaves, and strong medicinal odor, is a common and widely distributed plant. Sometimes eight or ten feet high, it makes the most characteristic bush dotting the bleak stretches. The beautiful silver-white holly, which is sold at Christmas time in Southern California cities, grows in rocky or gravelly situations where the soil is slightly alkaline. It is not a true holly as it belongs to the genus *Atriplex* but its leaves give good reason for its common name. Several other species of *Atriplex* including quail brush are found.

The only plant on the Mojave Desert which assumes sufficient size to be thought a tree is the tree yucca, called by many the Joshua tree. Tree yuccas often grow in groups reminding one of a scattered forest. The older trees, some thirty feet high, are branched into rounded heads each densely clothed with sword-like leaves. It is neither a cactus nor a palm. The soiled white flowers which appear in the spring have a somewhat disagreeable odor.

Probably the largest tree yucca in the southwest is a lonely sentinel in the Antelope Valley in northern Los Angeles County, twenty miles due east of Lancaster. This

tree is twenty-three feet in circumference and is sixty-four feet high. Five adult people can stand shoulder to shoulder in front of it and still not conceal the whole base of the tree. Thousands from nearby communities visit this interesting landmark of the desert.

An agave or century plant long furnished the Indians with a drink called mescal. The new flowering stalk when cut and properly roasted in a pit filled with live coals furnishes a "brown mass, as sweet as molasses" and with a seductive flavor. New growth of some of the yuccas was likewise utilized.

As writers on the desert have phrased it, perhaps Nature means only to be just and not unkind, for when, with the magic of spring rains, the desert breaks into bloom, its beauty overwhelms any thought of sterility. Wild flowers appear in profusion, wild flowers of the brightest colors. What has looked like a dreary stretch of sand becomes clothed with green plants and then with patches of flowers of unusual beauty and fragrance. Even a mountain meadow abloom fades in comparison. The seeds have been there in abundance and have only awaited moisture for rejuvenation. The display varies according to the season. Fullness of bloom comes rarely, bountiful seasons being those when rain comes at short intervals and extends over several weeks.

In the spring of 1927 there was such a notable showing of gorgeous colors that thousands journeyed to the desert to see it, and hotel accommodations were at a premium. A bunch of flowers picked at this time showed thistle sage, menzelia, gilia, ethrurial sphere, golden brodiaea, evening primrose, and several species of sand verbena and of composites, including the desert aster. The sand verbenas or abronias are among the commonest flowers. They grow under most adverse conditions and bloom profusely, supplying much of the carpet of color.

Reptiles

In both species and individuals, lizards are abundant in desert areas. Though the poisonous Gila monster has never been taken within the State of California, there is another large sluggish lizard, eighteen inches in length, the chuckwalla, that is fairly common in rocky places in both the Mojave and Colorado deserts, and is often confused with the one and only poisonous lizard in the United States. The heavy tail strikes powerful blows in defense, and by inflation the chuckwalla wedges itself in the cracks of rocks in such a way that enemies are seldom able to pull it out. Though wrinkled and ugly, it merits close study for it is unique in many ways. In food habits this lizard differs from others in that it is almost entirely a vegetarian, feeding upon flowers and leaves. The Indians used this reptile for food, roasting it over hot coals.

One of the most remarkable of lizards is found commonly on the desert. A circlet of horns around its head has given it the name of horned lizard, though "horned toad" is the more familiar name. Of such outstanding interest is this reptile that stuffed specimens were once in great demand at all curio stores. The author of this book earned some of his pin-money as a boy selling these lizards at ten cents each. On making inquiry among small boys one finds that a mysterious habit described as "spitting blood" is a source of much discussion. Study has shown that certain "horned toads," when teased, eject blood from the eye. First there is a swelling of the eyelid as reservoirs fill with blood and a final rupture of the lid forces the blood out in a fine stream. The early Spanish Californians called the horned lizard the "sacred toad" because it wept tears of blood. Although supposedly the animal uses this mechanism as a means of frightening enemies, yet this explanation is not entirely satisfactory. Some

individuals seem to have the habit well developed, others appear to lack it. The blood is in no way poisonous and unless the odor is repulsive to animals, it is hard to see how the habit can be of direct use to the lizard.

An interesting hypnotic effect is obtained by stroking a horned lizard on the head. Lowering its head, the reptile closes its eyes and goes to sleep. It may then be maltreated or even turned on its back, a treatment it usually resents, without being awakened. This habit may be a "playing possum," but it has the appearance of hypnosis.

The food consists principally of ants, although the smaller beetles and flies caught alive on a viscid tongue with a quick motion are eaten with relish. The eyes of this lizard quickly detect a moving insect. The body is raised and lowered by the front legs several times, perhaps to gain perspective. A quick dart and back-off and the insect is swallowed with little or no mastication.

In addition to the protection of bone-supported horns on the head, a covering of spines on the back and a fringe of them on the sides, this lizard can turn itself into a pneumatic pad. After filling its lungs full of air and bloating itself up like a toad, it can even be stepped on without serious injury. Shelter during the heat of the day is found by burrowing beneath the sand, leaving only the nostrils exposed. A wriggling motion of the head and body serve to drive the animal beneath the sand and a shake of the tail helps to cover it completely.

The horned lizard presents a fine example of protective coloration. Wherever its home, it resembles the color of the surroundings so closely that it is practically invisible except when in motion. Specimens from the white sand of the desert are very light in color, those from the black lava belt are almost black, whereas those from the varicolored mountain districts show red and even bluish markings. Experiment has shown that both temperature and

light affect the color. Put in a warm oven, a horned lizard turns light in color; on ice it turns dark. Pigment cells with tube-like branches distribute or restrict the pigment by contraction or expansion. Though the color change is comparatively slow in these lizards (the chameleon changes quickly) it may readily be tested.

Five varieties of horned lizards inhabit the states of California and Nevada. Two species are found on the southwestern deserts. The desert species are lighter in color and the circlet of horns on the head is reduced in size.

Most desert lizards are protectively colored and display great speed when disturbed. Perhaps the one with the most beautiful color pattern is the whip-tailed or tessellated lizard which carries a mosaic pattern. Along the toes are flattened spines that increase its supporting surface and prevent its sinking into the sand. It can move over the softest ground with great speed. The collared and the leopard lizards catch the eye because of their brighter coloration. Both of these lizards resort to an unusual mode of locomotion reminiscent of their possible giant ancestors, the dinosaurs, many of which lived their lives in an erect position. When these lizards are alarmed, they rear upon the hind feet and run erect for considerable distances. Some photographs of one of these lizards in motion, made at the American Museum of New York, could pass for miniatures of the giant dinosaurs of the Age of Reptiles.

On the mesas, west of the Colorado River, is found one of the native tortoises of the United States. Existing on green vegetation it seems to be able to live at a great distance from water. Hibernation appears to be helpful in tiding over the winter. The desert coyote is said to be an enemy, as the toothmarks on the shells of many tortoises indicate. Like other members of the family, it apparently lives to be quite old. A year's growth makes no

easily perceptible difference in size. Two of these desert tortoises were kept in the Chamber of Commerce rooms in Los Angeles for many years where they subsisted on lettuce. A specimen held in captivity in Yosemite Valley escaped. Apparently winter colds did not injure it, for when found the following spring it appeared to be in good condition. Here again was a favorite food of the Indians.

A common snake of the desert cañons, and of semi-arid regions as well, is the red racer. Long and slender and coral red in color, this snake occasionally attains a length of six feet. No California snake develops greater speed. A streak marks its progress, and after stopping suddenly the reptile just as suddenly disappears, owing to its protective coloration. This snake catches lizards easily because of its speed.

The horned rattlesnake or "sidewinder" is restricted to southwestern deserts. A protuberance over each eye gives it its name, and its strange mode of locomotion gives it its nickname. In movements the axis of the body is at an angle to the direction of progression; the snake appears to loop its way over the yielding sand. The track left in the sand is not continuous as it is with other snakes, but is a series of oblique S-shaped lines about the length of the snake and from three to six inches apart. Lizards of several species, pocket mice and kangaroo rats are the main items in the sidewinder's diet. It is seldom seen in daytime because it is sand colored and because it buries itself in the sand or hides in a depression. The sidewinder is one of the few snakes that move about at night. This noctural habit in reality decreases danger to people, although it is usually mentioned as increasing danger.

Raymond L. Ditmars has called attention to the interesting adaptation by the sidewinder to a desert habitat: "The hue is pallid, either pinkish, yellowish, or pale gray

in matching the sand areas over which the species is distributed. This reptile wanders over sand that is often as fine as powdered chalk and as the snake is comparatively heavy bodied, it would be at great disadvantage in pursuing its prey or escaping from enemies if compelled to crawl like the ordinary rattler, which seldom leaves firmer ground or a near retreat into rocks or heavy clumps of vegetation."

The sidewinder is so developed that it flattens the body, and by loops thrown rapidly forward in a plane parallel to the ground, literally walks off sideways at an oblique angle to the direction to which the head is pointed. The action is quite astonishing to the observer not familiar with the ways of this snake—being utterly foreign to any anticipated movement attributed to serpents generally. Rushing off in this fashion to a safe distance, the sidewinder further flattens the body until the sides assume the sharpness of a wedge, then, by wavy movements, it shovels the sand over its back and sinks out of sight. In fifteen seconds' time the snake is imbedded, all but the top of its head, with the short projecting horns appearing like debris from a cactus. The pale eyes remain uncovered but match the hue of the sand.

Although reputed to be especially poisonous, the sidewinder's small size and correspondingly short fangs and diminutive poison glands make it obvious that, unless the poison is of greater strength, the horned rattlesnake is to be feared less than some of the larger varieties. With greater knowledge of reptiles and slow dispelling of superstitious fear, it is becoming clear that rattlesnakes constitute no great menace to human life.

Though serum treatment for rattlesnake bite is proving efficacious it is seldom available, for there are so few deaths that it does not pay to produce serum in the United States.

It is largely imported from Brazil, though recently some has been prepared at Stanford University.

Probably not more than twenty persons die from snakebite annually in the United States, as against thousands in southern Asia. Seldom have there been more than five deaths from this cause in a year in California; the larger proportion always are children less than six years of age. In years past many whose deaths were attributed to the bite of a rattlesnake apparently died of alcoholic poisoning as a result of the treatment. Nowadays one bitten by a rattlesnake has more than ninety chances out of a hundred to recover. To keep the injected poison out of the circulation and away from the heart is the important thing. Immediate cutting of the wound to cause profuse bleeding is most important.

Invertebrates

A number of poisonous insects are found on the desert. Contrary to the usual view-point, the centipede, a long, flattened, yellowish creature with many legs, does not "sting with every leg." The first pair of legs is modified to act like jaws and each of these jaws has a poison gland usable in obtaining insect prey. The smaller species seldom give trouble but the larger ones of desert areas can give a painful bite.

The sting of the scorpion may well be feared, but the pincers are harmless. When houses were less insect-proof than now a person occasionally put his foot in his shoe on some unlucky morning and nursed thereafter the painful sting of a scorpion. However, the sting is not likely to be any more serious than that of the honey bee. The "vinegarone," its Spanish name meaning "kill deer," does not deserve its reputation as a poisonous species for no poison glands have been found in salpugids, as they are known to zoologists.

Though most spiders are not dangerous, all spiders have poison glands and if they bite, which they seldom do, a painful irritation usually results. Tarantulas, the largest spiders, are not "deadly poisonous" but the effects of the bite may last several days. The black widow spider, with an hour-glass-shaped mark on the under side, however, has a particularly virulent poison. The bite is serious and a number of deaths are recorded. Nervous symptoms, sometimes lasting weeks, and severe pain are accompaniments of the bite. Personally, I should prefer running chances with a rattlesnake bite than with that of the black widow or any of its wide-spread relatives. The consoling thing is that this spider seldom bites, even under provocation.

Velvet ants, termed "cow killers," large, hairy, wingless forms, inflict a painful wound but one not more serious than that of some wasps.

Mammals

Less than forty mammals are found on the Mojave Desert and more than twenty of these are rodents. The total for the southeastern deserts mounts to about sixty-five. The prong-horned antelope and the mountain sheep are the main hoofed animals that have been able to gain sustenance. Coyotes, foxes, skunks and wildcats are the principal carnivores. Many of the mammals of the desert appear to depend upon speed for escape from their enemies. Some observers have attributed these fleet types to the severity of the competition. The comparative absence of good cover, and the absence of impediments to progress may be equally logical explanations.

Mammals found in greatest abundance are seed eaters. The pocket mice and kangaroo rats, living in burrows and foraging at night, have developed cheek pouches for carrying seeds, and long hind legs and long tails.

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Large eyes are reminders of their nocturnal habit. Food is stored to tide over the winter shortage of seeds.

A low mound with several entrance burrows discloses the home of the kangaroo rat. Tapping on the ground and noting an answering sound from below helps to determine the occupied burrows. Kangaroo rats hop several feet at a single jump and the long tail acts as a prop and balancer. The short front feet are utilized in gathering and holding the seeds which make up their food.

Numerous theories have been advanced to explain how such a mammal as the kangaroo rat can carry on life processes with no more moisture in the food than that obtained from the eating of various seeds. Kangaroo rats have been kept in captivity for many months with no water and with the driest of foods. A pocket mouse was kept in a healthy condition for more than three years on a diet of dry barley and wheat. Some other desert rodents secure sufficient water by eating succulent plants, but kangaroo rats and pocket mice appear to be independent of a source of free water. Recent experiments have shown that carbohydrates, fats and protein may be chemically converted into fifty to one hundred per cent of their weight of water by oxidation or molecular change within the cells of the body, thus supplying much of the water necessary for vital processes. Birds and reptiles are known to conserve moisture by eliminating poisonous wastes as dry salts of uric acid. Desert mammals have dry, firm skins which retard perspiration, and the excrement has only a minute trace of moisture. They avoid the drying air of daytime by developing burrowing or nocturnal habits.

Among the larger mammal inhabitants of the desert is the desert fox. This predator is especially abundant though seldom seen because of nocturnal habits. Small size and pale coloration mark this desert denizen. It is of extra-

ordinary speed, and resorts to a burrow for a home. This fox is the natural enemy of kangaroo rats, pocket mice and ground squirrels.

Birds

If we count the migratory birds and those which frequent the water of ponds and streams, about two hundred varieties of birds are found on the southwestern deserts. The one American stork, the wood ibis, and that beautifully colored bird with its peculiar bill, the roseate spoonbill, are tropical species that have been recorded along the Colorado River. Several thrashers are successful residents and a species of quail, called Gambel quail, replaces the better known valley quail. In fact, three kinds of quail, mountain, valley, and desert, occasionally intermingle at the western border of the Colorado Desert, and hybrids have been taken.

The largest of North American wrens, and one dubbed "the most unwrenlike of all," builds a large bulky oven-shaped nest in cactus, hence its name, cactus wren. Its rapidly uttered loud call is one of the characteristic sounds of the desert. The song, a plain trill, is saved from monotony by variation in loudness, rather than pitch. A white stripe over the eye, white throat bordered below by large black spots, are striking features of this spotted bird. Like other wrens, it carries a jerky tail and sings with head up and tail down. Though the large bulky nests of sticks and grasses are to be seen everywhere in the cactus, yet their owners are shy and secretive. In seeking shelter from the sun and also at night, the males occupy old nests, or those built purposely.

Another bird of the desert, the verdin, builds a globular nest and occupies it throughout the year. Pairs or family groups are the rule and there are few shrubs that do not harbor them. In the absence of thick foliage the solid little nests with covered entrances are conspicuous. Thorny

sticks are most often used and this bird architect erects a sturdy structure, proof against enemies. Apparently males build roosting nests less elaborate and with less lining. At any rate here is a bird that clings to his or her home throughout the year instead of deserting it as most birds do during the winter. Whether the verdin goes without drinking has not been ascertained, but nests are often found miles away from the nearest water.

Only a few California birds show the bright, striking colors so prevalent among tropical species. When the subject is mentioned one thinks of the orioles and the western tanager, but fails to add another one with red in its plumage, unless familiar with desert birds; then one adds the vermilion flycatcher. No wonder this bird has a reputation when found amid such pale surroundings. Unless classified as a migrant from the tropics, the bright red of breast and head is difficult to reconcile with other desert inhabitants. The phainopepla or silky flycatcher, with its contrasting black and white, may pass unnoticed, but not so the vermilion flycatcher Though the greater number of birds of this species move southward during the winter, a few remain in favorable localities. When next on the desert, watch for this brightly colored flycatcher!

Roadrunners have a strange appetite. They feed largely on lizards, though snakes also fall victims often enough to give the basis for a pretty legend that has often appeared in print. The roadrunner is said to be a deadly enemy of the rattlesnake, searching the rattler out, building a cactus hedge about it to prevent its escape, and successfully dispatching the snake by well-directed blows on its head with the powerful bill. Two facts have given background for this myth: roadrunners sometimes kill and eat snakes; cholla cactus, after decay, leaves little hedges of thorns often somewhat circular in shape.

In Mission Cañon, Santa Barbara, I came upon a road-

runner with a fence lizard in its mouth. The bird approached quite close as I stood still to see what would happen. The bird held the lizard through the middle of the body and occasionally shifted the reptile's position to secure a better hold. The long tail of the bird beat rhythmically forward and backward. Apparently bent on carrying the lizard to young in its nest, the bird, a female, leaped easily over a four-foot fence, with two strokes of the wing reached the top of a five-foot stone wall and then followed the middle of the road up the cañon. I followed and only gave up the chase when the bird started off through thick brush.

W. L. Finley found and photographed a pair of roadrunners in Arizona that were feeding their young almost exclusively on whiptailed lizards. The lizards were placed head first in the open mouth of the nestlings and often the long tail continued to dangle out the mouth for an hour afterward, slowly disappearing with each successive gulp of the young bird. No wonder it is nicknamed "lizard bird." Find a nest and the feeding operations will furnish you with continual amusement.

Though the roadrunner is a relative of the cuckoo, it builds its own nest. This ground cuckoo of America does not have the parasitic habits of the well known European bird, which forces other birds to rear its young. However, in one respect the nesting habits are peculiar. Either incubation begins immediately on the laying of the first eggs, or successive clutches are deposited in the same nest before the young are grown. At any rate one may find fresh eggs, newly hatched young, and well feathered young in the same nest. When first hatched the young roadrunner is "most hideous" in aspect, with coal-black skin and ungainly form. When nestlings are disturbed they attempt to frighten the intruder by making a clicking sound with their bills.

About ninety per cent of the food for the year is made up of animal matter and ten per cent of vegetable. The one fruit most relished appears to be that of the sour berry, a kind of sumac. Chief among the insects are beetles, grasshoppers, crickets, caterpillars, and this is one of the few birds that will eat hairy caterpillars. The roadrunner seems to be adept at catching cicadas. Scorpions are often taken. The rapacious habit is evidenced by the interest in mice and other small rodents and an occasional bird. Of outstanding interest, however, is the roadrunner's preference for lizards.

In spite of continual complaints from sportsmen that the roadrunner is destructive to quail eggs and young, little support was found for this accusation in the analyses of the stomach contents of eighty-four birds taken in California, each month of the year represented. A preponderance of the evidence favors the view that this bird is valuable as a destroyer of rodent and insect pests.

Fabulous tales are told of the speed developed by this bird, but vaqueros report running it down on horseback and an automobile speedometer registers but ten to twelve miles when pressing a roadrunner to top speed.

Modern modes of travel and means of furnishing a water supply have taken the main discomforts from the desert areas. The sand storms and the heat of midday remain, but these are but temporary inconveniences. These overemphasized disadvantages may well be overlooked and appealing visions substituted. Flowers bloom early and birds nest early while climatic conditions are most favorable. In the desert may be found striking, unique forms of life. Adaptations to environment are so obvious that study is encouraged. Every lover of plant and animal life should accept the invitation thus given to visit the desert and learn at first hand of the wonders it holds in store.

Chapter VI

CHAPTER VI

Trees

Many a tree is found in the wood,
And every tree for its use is good;
Some for the strength of the gnarled root,
Some for the sweetness of flower and fruit;
Some for a shelter against the storm,
And some to keep the hearthstone warm;
Some for the roof, and some for the beam,
And some for a boat to breast the stream;
In the wealth of the wood since the world began
The trees have offered their gifts to man.

—Henry Van Dyke.

WHEN DISCUSSING the trees of California one must resort to superlatives. The largest, the tallest trees, the grandest extent of forests and greatest variety of cone-bearers, all may be credited to California. Furthermore, it would be hard to find more interesting trees than the unique Washington fan palm and several other desert species. The forests of the eastern United States are largely deciduous; those of the west, evergreen. More than two hundred varieties of trees might be confined to a thousand square miles in eastern states whereas a census on a similar area in California would total about thirty-five. Only two trees are common to the east

and west; the quaking aspen, *Populus tremuloides*, and the black willow, *Salix nigra*. Though the former is restricted to high altitudes in the mountains and the other to the Great Valley, they belong to the same family and their light hairy seeds are of the type which secures wide dispersal.

Certain cone-bearing trees are not only limited to the State of California, but have a remarkably restricted local distribution. The Monterey pine is found only near the coast from San Francisco Bay to central Monterey County, a range of 130 miles. In the southern part of its range it forms sizable forests. On two islands in the Santa Barbara Channel a variety is found also. The Torrey pine covers but a few square miles of seacoast mesa near San Diego and also grows on Santa Rosa Island. The Bishop pine is considered another coastal species. The Santa Lucia Range harbors the only Santa Lucia firs to be found anywhere. The Gowan cypress is found in two widely separated places: Monterey County and on the Mendocino coast. On the shore near the mouth of the Carmel River in Monterey County grows the Monterey cypress, most restricted of all. Jepson speaks of the Monterey peninsula as an isolated arboreal island where grow four cone-bearing trees of limited distribution: Monterey pine, Bishop pine, Monterey cypress and Gowan cypress.

Imagine a continuous forest of trees covering an area five hundred miles long and twenty-five miles wide. Such is the extent of the forest which covers the west slope of the Sierra Nevada. At lower elevations trees are scattered; at timber line they are dwarfed. The central strip is a mixed coniferous forest composed of five species: western yellow pine, sugar pine, white fir, red fir and incense cedar. All of these trees reach their greatest development in California. The mountain pine or silver pine, and the lodgepole or tamrac pine are secondary species along the upper

edge of the main forest, and the black oak a secondary species along the lower border. Ofttimes certain areas stand so thick with young growth that it is almost impossible to force one's way through. The mature forest is often park-like, leaving great aisles where traveling away from trails is a delight.

Cone-Bearing Trees

By common consent the big tree, *Sequoia gigantea*, is considered the most remarkable tree found on the earth's surface. Its enormous size and height, great age, ancient lineage and present restricted habitat combine to make this giant unique among trees.

The beautiful symmetry of this tree, with its slightly tapered trunk, leads many a visitor to a grove to be disappointed. But if he compares a tree with some person standing at the base, or attempts measurements, the size becomes more impressive. If he is a Californian, he is already acquainted with larger trees than are found elsewhere: yellow pine, sugar pine, Douglas fir, and the contrast is correspondingly less.

The average tree fifteen inches in diameter and fifty feet high has a combined leaf area of one third of an acre—nearly fifteen thousand square feet. These leaves use quantities of water. Much water is evaporated from the leaf surface. Most of this required water comes all the way from the roots via tubes in the outer sapwood. There often is thus lifted 125 gallons per day. An oak tree is computed to give off 120 tons of water in a season. Vegetation puts back into the air as much water as is carried by all the rivers of the world. Sap travels at the rate of thirty to forty feet an hour in some trees and the pressure exerted to raise the column of water is tremendous. Therefore, in quantity, in speed and in pressure the sap flow of a tree is fairly well known, but mystery still surrounds the exact

way in which the tree accomplishes the necessary circulation.

Think now of the raw products used by a large sugar pine, by a sequoia, even though leaf surface is reduced. The sap necessary to the well-being of such great trees must be enormous. The distance the sap has to travel before it can be utilized by the leaves is much greater than that in the average tree.

The maximum age of such common forest trees as pines is about four hundred years. It is therefore of outstanding interest that there should be trees which live for three thousand years and more. The big tree is termed "the oldest living thing." Annual rings indicate that some of the larger trees which have been cut ranged from two thousand to three thousand two hundred years old. It may be that living specimens are still older.

John Muir called the big tree "nature's forest masterpiece." The sequoia is found in scattered groves at elevations around six thousand feet on the western slope of the Sierra Nevada. Apparently the thirty-two groves, usually found on flanking ridges, are the remnants of the vast forests existing in pre-glacial times. Glaciers swept from the cañons the groves of big trees, and they have succeeded in persisting only on flanking ridges at a distance from ice-cut cañons.

E. W. Berry reminds us of the antiquity of the living big trees as follows: "Year after year the sequoias have been adding layer after layer to their girth in ever widening circles. The thousands of tons of bark shed by each tree during its long career, the tens and hundreds of thousands of tons of sap that have coursed through their venerable trunks; and the innumerable progeny of a single tree in the older more propitious day—a contemplation of these questions assists us in realizing the true proportions of these forest monarchs. Imagination, however, falls short

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in its attempt to picture the exquisite beauty of the virgin forest, standing age after age in all its unsullied glory—a veritable forest primeval."

In the annual rings it has been possible to trace a climatic record covering several thousand years. Certainly the years of drought and the years of plentiful rainfall are indicated and one might well check on the famine in the days of Elijah and other historic events. Forest fires are not a new thing, for the sequoias tell us that as long ago as the year 245 A. D. these trees were damaged by fire and that since 1685 fires have periodically swept the pine forests.

Impressed with the age of these great trees, one may well inquire as to the reasons why they have survived so many centuries when a pine tree has a maximum life of only four hundred years. There are at least three reasons that help in explaining their longevity: First, these trees are wonderfully protected from a tree's greatest enemy, fire. A thick coating of shreddy bark gives remarkable protection to the growing layer of the tree and, lacking pitch, fire does not get a firm foothold. The second greatest enemy of trees is the insect. There are more than four hundred insects injurious to oak trees and more than eighty that attack pine trees, but there is yet to be found a seriously injurious insect which preys upon the redwood or big tree. The third great enemy of trees is fungus. The tree under discussion lacks pitch but is full of tannin. This is a preservative which defends the tree against the main agents of decay, hence it is safe to say that some of the fallen trees have lain on the ground for centuries and yet they are of fit condition to be cut into lumber. The ability of these trees to withstand the three great enemies of all trees—fire, insects and fungus—at least makes a start on an explanation of why redwoods and big trees survive when other conifers die.

In the northern groves there are few young trees. The

average person would overlook what few are to be found. Does this mean that these trees are not producing viable seeds? More probably the lack of proper moisture, soil and sunshine prevents germination, and the deep litter under the trees keeps a sprouting seed from getting its roots into soil. In Sequoia National Park, where there are some fine seed beds and sizable saplings, it is noticeable that such growths occur where some large tree falls, stirring up the soil with its roots and allowing sunshine to reach this prepared seed bed. Admittedly the southern groves are reproducing themselves much better than the northern ones, but the death or destruction of a mature tree is the curtain raiser for the appearance of new ones.

Sequoias also are not only old individually but are trees of ancient lineage. Records left in the rocks disclose the fact that this kind of a tree flourished on the earth when giant reptiles ruled both land and sea. The rock record also shows that extensive forests of these trees were found over much of the earth's surface. Fossil remains have been found in Spitzbergen, Greenland and North America. The famous petrified forest of Yellowstone National Park is made up of near relatives of this tree, as is also the petrified forest in Sonoma County, California. In the latter instance a forest was apparently overwhelmed by scoria from the nearby volcano St. Helena and the trees were solidified by seepage from overlying material, mineralization taking the form of jasper, chalcedony and like minerals.

Two kinds of redwoods now living, considerably different in appearance, habit and distribution, remain to stir our admiration. One is called the redwood tree, *Sequoia sempervirens*, the other, the big tree, *Sequoia gigantea*.

The original stand of redwood trees was found along the north coast region from southern Monterey County to just over the Oregon line, a strip about twenty miles wide and four hundred and fifty miles long.

A comparison of the redwood tree with the big tree shows that the big tree usually grows older, is thicker trunked, has a more rounded crown with heavier supporting branches, and awl-like leaves. The coastal form, or redwood, on the other hand, grows taller, has a pointed crown, with upward-inclined branches, and the foliage is made up of half-inch leaves in flat sprays. The redwood in contrast with the big tree is communistic, being found in solid stands and being subject to stump sprouting. The big tree, on the other hand, grows in mixed forests.

The symmetry of its column, the red-brown tones of its bark, and the fern-like character of its leaves, mark the redwood as a thing of beauty. Like the big tree, it is so tall and symmetrical that its actual size is always deceiving.

Without claim to being the largest of trees, the coast redwood can probably claim the distinction of being the tallest of trees. Even when one stands among these giants, he is loath to believe that the taller ones tower up three hundred feet in the air. One that has been measured reaches three hundred and forty feet.

No forest produces so many board feet per acre as does the redwood forest; a single tree makes several carloads or a shipload of lumber. Not dependent on seed, the redwood sprouts several trees to take the place of one cut. It is estimated that eighty per cent of the present stand of coast redwood has sprung from stump-sprouts rather than from seeds. The sprouts when grown to sizable trees furnish a ring, oftentimes of perfect symmetry, and such "redwood circles" expand in size with succeeding generations. This formation seems to be more prevalent in the southern part of its range than to the north. To stand in the midst of a perfect circle and look upward along the encircling pillars to the circle of blue sky far overhead, yields a real thrill.

Deep shade and stillness give the redwood forest a

somber appearance when viewed by the average city dweller. Shafts of light are sometimes so conspicuous that they are actually photographed. Few birds or animals are to be seen. Such birds as frequent these forests choose to be high up in sunshine. Steller jays, creepers and winter wrens are the commonest birds which live in the forest shade; chipmunks and gray squirrels, the most abundant day-feeding mammals.

The Douglas fir is the commonest associated conifer, and the tanbark oak the most notable broadleaf. Undergrowth is luxuriant. Ferns of several kinds are most in evidence. The sword fern grows in profusion. A beautiful rhododendron produces massed green foliage and masses of pink flowers. The azalea chooses the stream banks. Hazel flourishes. The ground is often carpeted with oxalis. Redwood violet, clintonia, trillium, fritillaria, wild ginger, modesty and various orchids including calypso contribute a gay array of flowers. Larger undergrowth includes salal and huckleberry.

The fog belt seems to determine the distribution of the redwood. Redwood forests stop abruptly at the interior limit of the fogs which sweep in from the Pacific Ocean. The trees bathe their foliage in these fogs and appear to saturate themselves and help precipitate quantities of moisture which, falling like rain, furnishes moist soil conditions. Certainly no other forest of the West appears so saturated with moisture at practically all times of the year. In the southern part of its range, where humidity is less, groves of redwoods become more scattered. Here also the trees have redder bark. To the north solid stands predominate, constituting the most magnificent forest in the world. Four forests are of surpassing grandeur: the grove along the south fork of the Eel River and the west bank of the main Eel, culminating in the Bull Creek Flat and Dyerville Flat groves, about 10,000 acres in

extent; the immense Redwood Creek grove; the Klamath River groves; and the Smith River groves.

While the big trees of the Sierra impress one as of great age, the redwoods look thrifty and sturdy as if in the prime of life. Though badly burned, they continue to grow; although leveled to the ground by the wind or even the ax, younger trees may sprout from the fallen log as well as from the stump. Burls, abnormal growths caused by fungus, cut from the tree and placed in water, sprout roots and give forth beautiful decorative foliage. As a consequence, burls are cut and sold to be used as house plants. The clearing of cutover land is a difficult and expensive operation.

Redwood lumbering has proceeded with disastrous speed, for the whole state is dotted with redwood bungalows. Fence posts and grape stakes are in great demand. Redwood forests are not growing as fast as they are being cut. Awakening to these facts, several of the large lumber companies of the northwest coast are cooperating in one of the largest of reforestation projects. Not willing to depend entirely upon the second growth trees, which in forty to fifty years make a good quality of lumber, seeds are gathered in quantity, soaked in water, and are planted in carefully prepared seed beds. In fifteen to twenty days young plants appear above ground. The seedlings, after a year's growth, are planted on the cut-over land.

John Muir reminded us that these "kings of the forest," the noblest of a noble race, rightly belong to the world, but as they are in California we cannot escape responsibility as their guardians. Though many of the finest of the sequoias have been cut, in recent years interest has been stirred to save the best of what is left. The Save the Redwoods League was organized and has succeeded in saving for public use typical stands of coast redwoods and numerous strips on each side of the Redwood Highway.

This league, with a notable group of men at the head, so gained the confidence of the people that numerous forests were purchased and deeded to the league. And why should not such an organization be successful when the objective is saving for posterity, and for present generations as well, the world's finest trees?

According to Lemmon, the origin of the pine is thus recorded in Greek mythology: "Pan, the god who presided over the country and, consequently, had charge of rural objects and affairs, including forestry, had many love adventures, one of which was the attempt to win the love of a nymph of Mount Taygetus, the abode of the god. Boreas, the god of the north wind, became a rival of Pan and blew the nymph down from a high rock and would have killed her, but Pan, though unable to save her life, could change her form, so he changed the nymph into a pine tree (in Greek *Pitys*), and from that period pine trees have been seen clinging to rocks on mountain sides."

California is well supplied with pine trees, there being seventeen different species found in the state with eleven additional firs, spruces and hemlocks that belong to the same family. On no similar area of the earth's surface are there found such extensive pine forests.

The sugar pine is a tree with distinct individuality. Towering above neighboring trees, the heavily furrowed bark is a beautiful red-brown and the long pendant cones look like decorations. An occasional cone reaches twenty-three inches in length. After two years of growth the cones mature in August. Although each cone may contain two hundred seeds, reproduction is poorer than in yellow pine. The sugar pine, of all pine trees, grows tallest and largest. Maximum height is set at 240 feet and diameter at eleven feet, at four and one half feet above the ground. It thrives best at an altitude of from five to six thousand feet in the Sierra Nevada. The maximum

age is 500 years or a little more. Only one other state, Oregon, and Lower California, in Mexico, can boast of this beautiful tree. Nearly three fourths of the total stand is found in the Sierra Nevada.

Here is the story of the discovery of this wonderful pine: David Douglas, during his explorations in Oregon, found natives carrying pine seeds in their tobacco pouches which they used for food. Determined to discover the tree from which these pine seeds came, he turned southward. An Indian brought him a cone from the tree and told him of trees of great size. Then followed sickness with remarkable recovery, the weathering of a severe storm which blew down his tent, drenched him to the skin and leveled great trees, and lastly a narrow escape from hostile Indians. Undaunted, Douglas continued on his way and located the pines of his search on the headwaters of the Umpqua River in Oregon. Unable to climb the tall trees, he shot some cones down with his rifle. This brought eight Indians to see who fired the shots. They proved comparatively friendly. Thus was the sugar pine made known to the world. Douglas never again saw specimens of this pine, for on an exploring trip to the Hawaiian Islands he fell into a pit prepared for catching wild cattle and was trampled to death by an entrapped steer.

No other pine tree is so highly prized for lumber. In thick stands the sugar pine has a long, clean trunk, making the finest of lumber. Sometimes boards four to six feet in breadth are cut. The wood takes a high polish and is much used for drain-boards, window casings and doors. Every part of the tree is utilized. The less desirable cuts are made up into boxes and the still smaller portions into matches and toothpicks. Sometimes an owner has secured more than $1,000 for the cutting of a single tree.

The sugar pine is seldom found in pure stands, but

usually associated with yellow pine, incense cedar, and occasionally white fir and Douglas fir. The sugar pine, however, usually grows at higher altitudes than the Douglas fir, and more moisture is required for its growth than for yellow pine.

In general the sugar pine is the healthiest of the state's conifers. Seldom is it attacked by mistletoe, a serious pest on other pines in the same forest. The mountain pine beetle is probably the tree's worst enemy. The developing larvae cut horizontal galleries in the growing layer of the tree, sometimes girdling it. In spite of its hardiness, there is grave danger that this prize pine tree of California may fall victim to an insidious disease which singles out five-needled pines. The white pine blister rust, introduced originally from Europe, has wrought havoc in the white pine forests of the Middle West. Quarantine measures failed to prevent its spread through Canada to British Columbia and from there into the State of Washington. An alternate host of this fungus pest appears to be the currant. The only control measure yet devised is the systematic destruction of currant bushes. One can scarcely conceive of a greater calamity than the entrance of this dangerous disease and the consequent destruction of the world's most splendid pine trees.

Several other white pines (with five needles) are native to the state. The western white pine, or mountain pine, *Pinus monticola*, is a smaller tree which grows at higher elevations than the sugar pine. Its silver gray bark has sometimes given it the name of silver pine. The five needles are very short and the cones much smaller and less woody than those of its relative, the sugar pine. Around the mountain summits is found the white-barked pine, *Pinus albicaulis*. This is the tree that assumes such grotesque shapes at timber line, as the result of low temperature, poor soil, slow growth and high wind. Furthermore,

at the limit of its range it assumes a low, spreading habit and looks more like a shrub than like a tree. In many instances such a tree covers several square yards and the top appears flat as if it had been trimmed. A tree but three and one half inches in diameter and three feet high has indicated an age of 250 years. The cones are small and more rounded than those of the other white pines. The seeds form the main food supply of that conspicuous timber-line bird, the Clark nutcracker.

The foxtail pine, occasionally called Balfour pine, chooses the high granite crags of the southern Sierra Nevada, and peculiarly, it is also found in the extreme northwestern corner of the state. It thus has two widely separated centers of distribution. To find the foxtail pine in most typical form one must visit the Whitney Plateau, east of the Grand Cañon of the Kern River, a granite tableland 9,000 to 11,000 feet in altitude. When camped here, one may enjoy a sunrise over Mt. Whitney and the main crest of the Sierra and a sunset behind the Great Western Divide. On the Chagoopa Plateau there is an especially fine growth, probably the finest to be found anywhere. Most of the trees are from two to three feet in diameter but are probably several centuries old. Here one may study the effects of high winds and intense winter cold, two factors which must enter into the lives of these timber-line trees.

Likewise the limber pine, *Pinus flexilis*, grows at high elevations. The bark of the young branches is very white and contrasts with the dark brown of the main trunk. The flexible trailing branches give this tree its name. The limber pine is confined to isolated sections toward the southern end of the Sierra Nevada and to the higher mountains of Southern California as far south as Santa Rosa Peak. Since its natural home is in the Rockies this is a

tree that is supposed to have entered its western habitat by way of the desert ranges.

Next to the sugar pine the one that grows largest and is most highly prized for its lumber is the yellow pine, *Pinus ponderosa*. In climbing the Sierra one has hardly become acquainted with the digger pine of the foothills when he encounters small specimens of the taller western yellow pine with heavy yellow-green foliage and single tapering trunks. This is the tree that forms the main forest belt, the dominant tree at elevations of from 3,000 to 6,000 feet. Mature trees grow to be very large (two to nine feet in diameter) and very tall (60 to 225 feet), topped only by sugar pines. Probably the maximum age is around five hundred years, although this is reached by but few trees. The light yellow bark is broken into great flattened plates and is often described as being like an alligator's skin. Young trees, or those which have not begun shedding their bark, have a darker furrowed bark and are sometimes called "bull pines" in the belief that they are a different kind of tree. An especially fine example of a large yellow pine is one of the attractions of Yosemite Valley. Most hardy of all the pines, it adapts itself to a wide variety of situations. Although found in the Coast Range it is there much less abundant. It has no rival for beauty when the clean fine shafts are considered. Where the trees are scattered in park-like growth on the flats there is no forest more impressive. Seed years appear rather regularly and dense young growth is common. The cones mature in two years and then break near the base, and when falling to the ground leave a rosette of basal scales against the limb. This tree is therefore called a broken cone type of pine. The ground beneath the trees is usually littered with old cones from which the winged seeds have fallen. These cones are only three to five inches in length. At times the wind-blown pollen

fills the air and yellows the margin of every pond and stream. The closely attached cones hang in subterminal clusters, and usually in summer cones of two sizes are present, together with newly-formed pistillate catkins on the newest growth.

The yellow pine is highly prized for lumber. It is harder, more pitchy and splits more easily than the wood of the sugar pine. However, it is widely used. The sapwood furnishes fine finish lumber. During the Civil War a good grade of turpentine was manufactured from the pitch drained from yellow pines. Demand has never been sufficient to continue the practice.

At higher elevations (around 6,000 feet) yellow pines differ sufficiently from those at lower elevations to be given another name, that of Jeffrey pine. This tree forms extensive forests and is to be distinguished by its red-brown bark, blue-green foliage, and larger, denser cones, five to ten inches in length. In contrast the yellow pine has yellow-brown bark, yellow-green foliage and small cones seldom over four inches in length. There has been much discussion as to whether the Jeffrey pine is a distinct species or just a variety. Even entomologists, assert that the pine beetle attacking this tree is different from the one feeding on yellow pines, and foresters assert that the taste and smell are distinctive. This tree is included in the pharmacopeia, the pitch being considered desirable in treatments of respiratory complaints. A chewing gum advertised as similarly valuable is manufactured from the resin.

Every camper in the High Sierra soon learns that the gnarled, twisted tree with thin, scaly bark, and with two needles in a bundle, is the lodgepole pine, often termed "tamrac pine." The tree has a great vertical range and succeeds even at timber line. The fringe of trees about the source of every mountain stream and that around every

high mountain lake and mountain meadow is almost certain to be composed of lodgepole pine. Nowhere does the tree grow very large, nor very high. Rather does it impress one with its sturdiness. No other pine so invariably has twisted grain in the wood. This is noticeable on dead, barkless trees and at the scars left by fallen limbs. Even the scientific name *Pinus contorta* is based on this habit. The cone is a small one with a stem and it often persists on the tree for many years after it reaches maturity. Although the statement is sometimes made that the cone of the lodgepole pine does not open and shed its seeds until a fire opens it, this is certainly not the case with the Sierran tree, nor is this habit rightly referable to the tree elsewhere. It is the knob-coned pine that justifies this statement. Under every mature lodgepole pine, there is a litter of small open cones from which the seeds have fallen. Campers in the High Sierra often experience the necessity of brushing away a quantity of these cones in order to have a comfortable night in a sleeping bag.

In some places the lodgepole pine is extensively barked by porcupines, to which the bark is a favorite food. Rich in pitch, every injury is sealed with it. Mountaineers find the resin a satisfactory chewing gum as soon as the first bitter taste is reduced.

A trip through the northern part of Yosemite National Park is sure to disclose areas that might be termed "a graveyard of trees." The sombre aspect of these tracts has somewhat changed in recent years because of the young growth. Examination will show that the trees concerned are lodgepole pines. About 1904 the scourge which rapidly swept over great areas in the central Sierra Nevada became noticeable. Government officials soon located the cause but not the cure. Thousands of dollars were fruitlessly spent in control measures. Meantime, the

epidemic continued to spread. Two insects were responsible. A moth known as a needle miner (*Recurveria milleri*) lays its eggs on the needles of the lodgepole pine. No other pine is attacked. The resultant larvae burrow down the centers of the needles, destroying their usefulness. After turning brown, the needles drop off. Thus defoliated, the tree is sufficiently weakened so that it cannot withstand the attack of the mountain pine beetle, which by destroying the growing layer of the tree causes it to die. The moths fly in alternate years. In 1913, such myriads appeared that they became a pest to tourists. By 1922, encroachment of new areas had subsided and in recent years the two destructive insects involved have caused practically no damage. At one time it looked as if every mature lodgepole pine in Yosemite National Park would eventually be killed, but, as is so often the case, Nature performed a remarkable cure. Either some parasite, weather conditions, or some other factor, cut down the breeding stock to a minimum and damage to trees suddenly stopped.

Since the young lodgepole pines were able to withstand the attack of the insects, much of the dead forest is now being replaced by new growth. In some places the encroachment of mountain hemlock into areas denuded of lodgepole pines is to be noted.

Most of our pine trees are cone shaped in form with one main trunk, but as one enters the foothill country almost anywhere in California, the first pine tree encountered differs in this character, for it has a broad top and divided trunk. The foliage is gray and the large heavy cones hang in clusters near the tip ends of the main branches. Remarkably small sized trees (12 to 14 years) produce cones. It is known as Digger pine or Sabine pine. This tree has the distinction of being strictly Californian but exceedingly well distributed in both the coast range and

the western slope of the Sierra Nevada. Again it was David Douglas who discovered this tree during his travels in the California coast ranges in 1830 and 1831. His description of the new species was dated at San Juan Mission, Upper California, February 4, 1831, but there is nothing to indicate the locality where he secured his specimens.

This species is sometimes termed "nut pine." The seeds have the disadvantage of being very hard shelled, but their size compensates for this. Because the Digger Indians found these nuts a favorite food, Digger pine has become the white man's common name for the tree.

Jepson sums up this tree in the following terms: "Scarcely in any sense a beautiful tree, offering no comfort of shade to the inexperienced wayfarer who, dusty and sun-bitten, seeks its protection, scorned too, by the lumber men, it is nevertheless the most interesting and picturesque tree of the foothills on account of its scattered growth, its thin gray cloud of foliage, its variety of branching, and its burden of massive cones."

One pine tree has become famous because of a very restricted distribution in California. It occurs in one area covering about four miles on the seacoast of San Diego County where it is preserved in "Torrey Pines Park" near Del Mar, and in fairly extensive forests found on the Santa Barbara group of islands. As a consequence, it can be termed the rarest of California pines. The San Diego group of trees is separated from other pine forests by fifty miles. Since all are fairly young trees, it is difficult to say whether this is a last stand or a newly started one. Because of its exposure to high winds, the Torrey pine is usually a low, crooked, sprawling tree. Seldom does it grow to be more than eight to twelve inches in diameter. The long, heavy needles (seven and one half to thirteen inches) are arranged five in a bundle, and are the heaviest and strongest

known. The cones are attached to the limbs by a heavy stem and persist on the tree for many years. A tree planted in the botanical garden of the University of California, at Berkeley, has made a fine growth and is worth seeing. It would be hard to find a tree more variously unique: No other pine has such a limited distribution, none has such large flowers, hard nuts or such strong leaves.

Another coastal pine is now well known throughout the world for it is obtainable almost anywhere from nurserymen. The Monterey pine, one of the yellow pines, is found along the central California coast and islands where it even invades the sand dunes. Two islands in the Santa Barbara group contain groves of these trees and an isolated grove is to be found on Guadalupe Island off the coast of Lower California. The best-known Monterey pine forests are to be found on the Monterey Peninsula, where trees grow to be nearly a hundred feet high and three to four feet in diameter.

Resisting the storms from the ocean, the Monterey pine holds to the loose drifting sand. It might well be called a beach pine. It grows rapidly but is not a long-lived tree. For years, it has been recognized as a desirable tree for windbreaks and for watershed use. The unsymmetrical pointed cones appear three to five in a whorled cluster and take two to three years to ripen. The scales do not open and free the seeds until still later. The wood is seldom used for lumber because it is so full of knots, yet it is durable if kept away from soil. The chief use of the Monterey pine is that of a rapid-growing nursery tree, popular in landscape gardening. Water companies use it for watershed protection.

In the prickle cone or Bishop pine is found a near relative largely limited to a coast area north of San Francisco Bay, although specimens are found as far south as San Luis Obispo County. Cones, which appear three to five in a

circle, persist on the tree unopened for periods of from fifteen to twenty-five years. Furthermore, a tree starts producing cones at seven to eight years of age. Under the heat from a forest fire the cones slowly open and the forest is quickly reseeded.

The knob-cone pine is another tree which does not reseed itself until a fire opens the cones. The seeds hold their vitality for many years and when a forest fire destroys an area, the forest is promptly resown. As might be expected under these conditions, the symmetrical, hard, varnished cones remain on the trees for many years. It is found at lower altitudes in both the Coast and Sierra Nevada ranges. Seldom does the knob-cone pine grow more than thirty feet in height. Cones are produced at an early age on the main axis. The tree is loosely leafed, branched and rather unattractive in appearance. Mountaineers refer to it as "that queer little pine tree covered all over with burs." Nevertheless, from three standpoints it is a remarkable pine: "Constitutional vigor, reproductive capacity, and provision for seed storage." "Giving beauty for ashes," is the way Muir describes the transformation after fire has set the seeds free.

The pine tree which has so large a cone that it bears the name big-coned pine or Coulter pine is a common tree of the mountains of Southern California. It ranges as far north as Mt. Hamilton and is fairly abundant in San Luis Obispo County. What the cones lack in length, they make up in thickness, for they vary from ten to thirteen inches in length and from five to seven and one half inches in thickness, being the most massive borne by any pine. The talon-like spurs at the end of the scales help to identify this tree. Like the seeds of the Digger pine, the nuts have hard shells. The trees are large, tall, and long armed, with bunches of cones near the tips of the main branches.

The leaves are the longest (eight to fourteen inches) of any of the pine family.

Of the many who buy pine nuts in the market and feast upon the sweet meats exposed by the simple process of cracking with the teeth, there are few who know the tree from which these pine nuts or "piñons" come. There is good reason, for the piñon pine is limited to the great basin country east of the Sierra Nevada, though in a few places it is found on the western slope and in the Tehachapi Mountains. The tree is easily distinguished as it is the only single leaved pine known. The trees never grow large. The cones are small and do not produce very many seeds as compared with those pines having large cones. The Indians gathered the cones in quantity, freed the seeds by roasting, and tribes favorably situated exchanged them with Indians from the western slope for acorns which the latter were able to gather in abundance. It may be that the few scattered groves of piñon pines on the western slope of the Sierra have sprung from seeds dropped when an exchange was being made by tribes of Indians. At any rate, the arid plateau region is the real home of the piñon pine.

In the Cuyamaca Mountains of San Diego County and in the mountains of Lower California, a type of pine noted for its sweet, finely flavored seeds is to be found, named after Dr. C. C. Parry who discovered it during the survey for the Mexican boundary in 1848. The Parry pine, sometimes called beautiful piñon pine, has cones and seeds similar to those of the true piñon, but the needles appear in bundles of two, three, four or five, the latter more common towards the top, the threes on the lower branches, and the fours most common. It is also sometimes called the four-leaf pine. It is, perhaps, next to the Torrey pine, the one with most limited distribution.

The commonest tree associated with yellow pine, and

a tree which grows in great abundance in the Sierra, is the incense cedar, *Libocedrus decurrens*, shapely, and beautifully foliaged. The scale-like leaves and flattened branchlets, reminding one of the foliage of an arbor vitae, together with shreddy, red-brown bark on the mature tree, are characters sufficient to identify it. Full-grown trees may be as much as six feet in diameter and one hundred and fifty feet in height. The cones are small bottle-shaped affairs, less than an inch long, which, when opened, remind one of the conventional drawing of a *fleur-de-lis*. Two main scales separated by a third central one, give room for but four winged seeds. Seeds are produced in such abundance that thick nurseries of young trees through which it is practically impossible to force one's way, are not unusual. After a forest fire, the incense cedar and the yellow pine are the first trees to reclothe the mountainside. In general, this tree so resembles the big tree that it is often mistaken for it. The shreddy bark also leads to its misidentification.

The explorer Frémont discovered the incense cedar on the south fork of the American River while on his second expedition in 1844. The tree was described from specimens secured by the same explorer two years later. Because of the durability of incense cedar, young trees are widely used for fence posts and other poles. However, the commonest use of the wood is for the making of pencils.

The Douglas fir, if not known in its mountain habitat, is at least familiar to all at Christmas time when carloads arrive in every city and a beautiful young tree eventually graces nearly every fireside. The name of this tree commemorates the young Scottish botanist, David Douglas, discoverer of the sugar pine, who introduced the tree into Europe in 1827 by taking seeds from the State of Washington. One hundred years ago Douglas explored the Pacific northwest, braving hostile Indians and collecting

many new species of plants. The list of American trees and plants discovered and described by Douglas are counted in the hundreds. He was only 25 years old when he set out for America in 1823, yet he was already widely known as a scientist. He first saw the tree which later was to bear his name when he came to the Columbia River on April 8, 1825. The tree had been previously discovered by the Vancouver expedition on Vancouver Island in 1792. It was first named a pine but was finally given the name *Pseudotsuga taxifolia*, false hemlock, in an endeavor to show its relationship. However, though this tree is commonly termed a fir, and is also known as Douglas spruce, it has but superficial resemblances to these well-known trees. The lumber is marketed under the trade name of "Oregon pine." Until a few years ago a lumberman would not understand a customer who asked for Douglas fir, so established had this trade name become. Its many names may at least remind us of unique characters which have kept the botanist from grouping this tree with the firs, spruces or pines.

A near relative, the big-coned spruce, *Pseudotsuga macrocarpa*, grows in the mountains of Southern California and except for its larger sized cone is very similar in form, but not in certain other characters. Forests of the big-coned spruce are to be found in the Sierra Madre and San Bernardino ranges. Its distribution is limited to the area from the Tehachapi Mountains on the north to northern Lower California. It may be regarded as only an arid region variety of the Douglas fir.

Douglas fir is widely distributed over the western United States, being found in the Rockies, Cascade, Sierra Nevada and Coast ranges. It grows to maximum height and size in Oregon and Washington where there are solid stands. In California it is usually found in more scattered stands and is secondary in importance to the pines.

The Douglas fir is graceful and beautiful with its drooping branchlets. The cones quickly identify this tree, for behind each scale there is a trident-shaped bract. The cones are pendant, fall off entire and litter the ground each season. The tree is a prolific cone producer. The needles have a slight stalk, whereas those of the firs lack any stalk. It differs from all other conifers with the exception of its one close relative, the big-coned spruce, in the red-brown, sharp-pointed, conical buds at the tip of each branchlet. The new growth for each year springs from this bud and the papery bracts remain as an additional identification mark. So regular is each year's growth that the nodes may be counted to obtain the age of the tree itself and the age of each separate branch. Of course the ages of older trees are not easily estimated because the bark has grown over the lower discarded branches. The light green color of the new growth at the tip of each branchlet contrasts with the older foliage and is most attractive.

No other forest tree produces such fine lumber. The wood is straight, close-grained and is largely free from knots. Furthermore, beams of great size, a hundred feet long and two feet square are easily obtained. When tensile strength is needed, "Oregon pine" is used. Bridge timbers, trusses, masts of ships, telephone poles, piling, are largely of this tree. Framework of buildings in California, as well as finishing inside, is furnished likewise. After the Temple of Heaven in Peking had been destroyed, the Chinese sought the world over to find main pillars to rebuild it. Suitable columns of Douglas fir were finally secured from Oregon as a result of diplomatic negotiations.

As a tree useful in reforestation it is of high order because of its habit of growth, vigor, vitality and aggressiveness. Extensive plantings of Douglas fir have been made in Germany, France and other European countries and in time it will have greatly exceeded its original dis-

tribution in America. Already it is the most widely cultivated of western conifers. The new boom for living Christmas trees finds growers resorting to the Douglas fir as the most desirable.

A long-lived tree is the Douglas fir; more than seven hundred annual rings have been counted on a single stump. Growth is slow after the second century both in height and girth. The tallest of Douglas firs measures 380 feet and trees of fifteen feet in diameter have produced 60,000 board feet of lumber. Young trees in California show an average growth in height of from six inches to two feet per year. The rapid growth, great size, high value of its lumber, and ease of culture, combine to place this among the most useful of the world's trees.

To many people the most beautiful tree in the state is the white fir, *Abies concolor*. From the standpoint of symmetry, it has a beauty all its own. The large fan-shaped branches come out in perfect circles around the main trunk, the needles are arranged in two rows and the tip of each branch divides into three branchlets. Young trees are often so thickly foliaged that the trunk is hardly visible, thus making a solid cone-shaped silhouette. The bark of the young trees is silvery-gray in color. Bark on mature trees, which sometimes grow to be six feet in diameter, is light and cork-like with an ashy-gray color. As on all fir trees, the cones are borne on the topmost branches and stand erect like candles on a Christmas tree. They must be admired on the tree, however, for on maturity they fall to pieces. On the ground the rod-like center and the scales can be retrieved, but not the entire cone.

The wood is light and of an inferior grade. It is much subject to fungus attack and quickly decays when in contact with the soil. Its main use is in the manufacture of fruit boxes and butter cases where a scentless wood is desired. Being a near relative of the famous balsam fir

of the eastern United States, it is not surprising that war demand for balsam led to the collection of this curative agent from blisters on the white fir. One need but prick a blister on the trunk of a young tree to secure clear, pure balsam.

In California, white fir is largely restricted to the middle altitudes in the Sierra Nevada; in the Coast Range it is restricted to the higher mountains north of Lake County; thence southward it is lacking until Mt. Pinos in Ventura County is reached. Thus the tree is lacking in a belt 360 miles in length.

Another fir with similar symmetrical growth forms sizable forests at the upper edge of the main timber belt. Because of its beauty it has been termed "the magnificent fir," though red fir is the usual book name applied. It is usually distinguished by its blue-green foliage, shorter needles, which have a tendency to turn upward, and by the much larger cones which sometimes reach eight inches in length and three and one half inches in diameter. Close examination of a cross-section of a needle will show it to be four-sided as compared with the elliptic cross-section of the needles of a white fir. Forests of red fir greatly appeal to any lover of beauty. The velvety textured red-brown bark of the red fir furnishes one of the most beautiful colors in nature. The foliage is more thickly set and gives the tree a heavier, more massive crown than that possessed by the white fir. The wood is reddish and soft, but still sufficiently durable to be used for bridge timbers and cage guides in mine shafts. This tree occasionally grows to a height of one hundred and fifty feet. Two varieties of the red fir are found farther to the north: one known as the Shasta fir, being found in the Mt. Shasta region, and the other, the Noble fir, with its extreme southern limit in the Siskiyou Mountains. The latter is a common tree in Oregon and Washington.

A fir tree of great beauty is restricted to a small area in the Santa Lucia Mountains of Monterey County. Hence it is called the Santa Lucia fir. It chooses the ridge nearest the sea and prefers the moist bottoms of cañons and dry, rocky summits. Its total range is about forty-five miles from north to south, and but a mile wide. Its isolation is complete, for no other fir tree is to be found within two hundred and twenty-five miles to the north, one hundred and forty miles to the east, or one hundred and twenty miles to the south. The tree proved of such interest to early botanists that at least six made special trips to see this rare tree or collect seeds for cultivation in European botanical gardens. The fathers at the nearest mission, San Antonio, used the resin from this tree as incense in religious ceremonies. It may be that Coulter, the discoverer of the tree, gathered his first information regarding it from the mission fathers. The distinctive features of this tree include a slender spire-shaped crown, peculiar bristly cones, broad, sharp-pointed leaves and long-pointed winter buds. The cones often hang in dense clusters, the topmost branches borne down with their heavy weight. The egg-shaped cones so bristle with slender needle-like bracts that the tree is sometimes called "the bristle-cone" fir. Though the branches give a broad base, the crown is slender and attenuated, giving the tree a distinctive appearance.

The juniper claims distinction because of its longevity and because of its ability to survive with practically no soil for its roots. The Sierra juniper appears to choose the granite tables near timber line; here it makes a start in some small crack in the solid rock and, clinging tenaciously to life, succeeds where other trees fail. Seldom does it grow to be more than thirty feet in height. The trunk is often sizable but tapers rapidly. This tree stump sprouts, often leaving the main trunk dead. A cross-section of the

whole tree shows annual rings of great number, indicating that the tree has stood anchored to the spot for centuries. The bark flakes off in ribbon-like strips. This was sometimes used by the Indians in tentmaking. The dwarf juniper ranges from the central Sierra to Mt. Shasta, the California juniper from Mt. Diablo through the Coast Range into Southern California; the desert juniper, the plateau region east of the Sierra Nevada, and the Sierra juniper, throughout the Sierra Nevada northward to Mt. Shasta and southward to the San Bernardino Mountains.

Limited to a small coastal area in Monterey is found a cypress which, although it seems incapable of extending its range naturally, now has a nearly world-wide distribution because it lends itself to propagation. In its native state nowhere is it found growing more than 350 feet from the shore, yet, through propagation, it is probably the most widely distributed California tree. The seeds are viable and growth is rapid, sometimes as much as three feet in a year. Tips of new growth may be used as cuttings but the resultant trees are not so hardy. Cypress hedges were once much in vogue and rows of cypress trees are used as windbreaks. Trees may be trimmed into various shapes. In its native home the young Monterey cypress grows into a pyramid shape, but old trees are grotesque with broad or umbrella-shaped tops and gnarled branches. Where exposed to sea winds, its bent limbs sprawl on the ground and the top is flattened.

A finer foliaged, smaller tree, the Gowan cypress, has a wide distribution from Mendocino County to San Diego; the dwarf or pigmy cypress grows only on the Mendocino coast, and the rare Macnab cypress grows in isolated groups in the northern coast region. All of these cypresses have round cones maturing in two years and overlapping scale-like leaves arranged on quadrangular branchlets.

Though little known as a forest tree, the Lawson cypress, known to the lumberman as Port Orford cedar, is a popular ornamental tree in America and Europe. In both height and diameter it is the largest member of its tribe. In young trees the branches trend upward, but assume a horizontal or drooping posture with age. Like those of the incense cedar, the branchlets are flattened; but the leaves are finer in the Lawson cypress. The small berry-like cones take but a year to mature.

Of true spruces there are but two and both assume better proportions in Oregon. The Sitka or tideland spruce favors a coastal strip as far south as Mendocino County, and the weeping spruce is restricted to the Siskiyou, Klamath and Trinity mountains where it is found in small scattered groups. This latter tree is seldom seen by botanists. The tree is well named, for the marked drooping character of its lower branches is a striking feature. Although most western trees were discovered and named by early explorers, the weeping spruce was not permanently put on record until 1884, though Professor William Brewer, for whom the tree is named, had previously procured a branch of it at "the west base of Mount Shasta," a locality where it has not been rediscovered.

In the California nutmeg we find a rare tree which grows in California, with a closely related species growing in Florida. Classified with the yews, its wood finds a like use, as it was highly prized by the Indians for the making of bows and the modern archer finds in it a similar use. The durability of the wood led the pioneer to use it for bridges. The elliptic or pear-shaped fruit is borne in quantity and this gives the tree an interesting appearance. When the fruit is halved, its appearance is not unlike that of the commercial nutmeg, hence its name. A sticky resinous secretion exudes from the flesh when green; the odor is agreeable. When roasted, the kernel is palatable

and has an aromatic flavor which was greatly relished by the Indians. In general, the tree resembles a fir tree but the sharp, stiff needles, the peculiar fruit and the different sort of bark, quickly disillusion an observer. The needles are arranged in rigid ranks and sprout from a flat fan-spread branchlet that divides in threes and fours. Although occasionally growing to be a hundred or more feet high, the California nutmeg is usually a small tree. The finest stand known is that near Duncan Mills in Mendocino County. The largest one in this stand is one hundred and four feet high with a clean trunk of forty feet.

The nutmeg is a distinctive California tree, and one to be appreciated for its beauty. Because of the comparatively small number of individuals it is a tree needing protection lest it be exterminated.

John Muir called the mountain hemlock "the lady of the snows." As recounted by one of his companions, he never tired of explaining how this tree pushes out of the rocks and grows skyward; how it bows to the wind and resists the storms; how it bends under mountain-loads of ice each winter, raising itself erect each spring to spread its trailing garments in the sun for a brief summer of joy. He was able to describe its moods, reveal its graces and indicate individual character.

Choosing the sheltered granite slopes of the mountains at timber line, the mountain hemlock clothes itself with thick branches from its base upward to its drooping top. The slender cylindrical shape, with little or no free basal trunk, is a distinctive feature. Most of the branches trend downward. Heavy snow often forces the young trees prostrate on the ground, but they are ready to spring up when the load is lightened. The abundantly produced cones remind one of miniature Chinese pagodas. The old story to the effect that the drooping tops of the hemlocks all

point east is not dependable, as investigation will show. The coast hemlock is found in the Coast Range as far south as Mendocino County; the mountain hemlock is distributed from Mount Shasta to the Kings River region.

Oaks and Other Broad-Leaved Trees

Oaks are world-famous for slow growth, contorted branches, strength and quality of their wood, and for their acorns which have furnished food for man, beast and bird. Oaks are trees abundant in species and in individuals. The entire State of California includes but fourteen varieties. Here in most instances differences between varieties are easily learned. To a group of deciduous oaks, those which drop their leaves in winter, is to be added a number of live oaks, foliaged the year round. All sorts of soil are selected, and oaks may be scattered or may form a solid forest. But compared with other places there are few individuals in California. Each oak bears two kinds of flowers. Tasseled catkins furnish the pollen for the bud-like developing acorn which usually appears on new growth of a separate branch.

Travelers in Chico, Butte County, are often invited to visit the Hooker oak on the old Bidwell ranch. Though this is a magnificent example of the valley oak with remarkable height, span of crown and trunk diameter, yet a still larger one is the Henley oak in Round Valley. This one is 150 feet high and 25 feet in circumference four feet above the base. Several others range from five to nine feet in diameter. Because they choose the most fertile valley soils with abundant water supply, it is natural that these oaks should grow to be of large size. Adult trees span two or three centuries, for annual rings indicate two to three hundred years of growth.

A white trunk and small, lobed leaves mark this strictly Californian tree. Where the valley oak is cleared

to make orchard land, difficulty is encountered by the orchardist, for the soil may have been drained of nutriment by the roots, or the fungus which attacks the roots of the oak spreads to the fruit trees so that the newly set trees do not thrive.

Although one of the most beautiful of the oaks, the valley oak has little value commercially except for fire wood. In fact the wood is the least valuable hardwood on the Pacific Coast. Some of the local names applied, "swamp oak" and "mush oak," indicate the contempt in which its brittle wood is held. Nevertheless, the valley pioneer utilized this oak for his log cabin and for posts, fence rails and stove wood. The large, sweet acorns are produced in great quantity. Indians utilized them; California woodpeckers subsist on them; and the rancher finds them good hog feed. Much of the charm of the landscape in the great level valleys is due to this ever-present oak often draped with mistletoe or wild grape. Jepson says no other tree is so characteristic of the lower altitudes, none other speaks so much for fertility of soil and none other approaches it in park-like effect in its natural stands.

A near relative of this first mentioned white oak is known as the Oregon oak or Garry oak, which chooses the mountainous coast region. It is noted for the whiteness of its bark, looking as if whitewashed. In contrast with the valley oak, the wood of this oak is second to that of the maul oak, being used for furniture, interior finish and ship-building.

A tree with different leaf contour and color is the blue oak, of the dry rocky foothills of both the Coast Range and Sierra Nevada, where moisture is scant and drainage good. It is said that too much water from a nearby irrigation ditch soon kills a blue oak, though a live oak may profit by it. A scattered growth of blue oaks is the first tree growth encountered on entering the Sierra

Nevada foothills and sometimes it ranges high enough to associate with digger pine.

One species of white oak seldom grows more than bush high and consequently is called scrub oak. It forms an important part of the chaparral belt. The shape of the leaves varies so widely that this tree is often a puzzle to a trained botanist.

In the acorns of the black oak (*Quercus kelloggii*) the California Indian found a palatable food after the bitter tannin had been removed by leeching. In the Sierra, Indians gathered and stored acorns for winter use and against a failure of the crop. This producer of large acorns grows to be a sizable tree thirty to eighty feet high, and sometimes reaches an age of 350 years. The color of the bark gives it its name and in this it contrasts with the white oaks. The leaves grow very large and each lobe has about three bristle-tipped teeth. Consequently, the black oak is easily distinguished from the white oaks with their leaves having smooth-edged lobes. This oak occupies the upper edge of the chaparral belt with the digger pines, and the lower part of the yellow pine belt, and is found in the Coast Range, the Sierra Nevada, and the higher mountains of Southern California, choosing the better soils. The newly forming leaves in spring are reddish or purplish and add more color than the surrounding green foliage of other trees. The wood is not as desirable as that from other oaks and is used more as firewood than as lumber.

The early Spanish explorers greatly admired the oaks they found growing about each seaport visited. Portolá, whose expedition discovered San Francisco Bay, was impressed with the magnificent growth of live oaks he found in the Santa Clara Valley. Later, botanists of the Malaspina Expedition in 1791 gathered specimens of the live oak and of the valley oak, and described them. The

beautiful rounded outline of the live oak and its thick evergreen foliage still catches the eye of every stranger and should be thoroughly appreciated by every resident.

There is no more typical tree of California nor one more abundant and widespread. Differences in the shape of the leaves and character of the acorns have led botanists to distinguish between the tree growing in the Coast Range and in Southern California from that found in the foothills of the Sierra Nevada, hence the names coast live oak and interior live oak. Burned or injured trees sprout from the stumps. This is fortunate for the sprouting acorns do not often succeed in life and when a young tree becomes established it grows slowly. The trunk and limbs are so short and the wood checks so badly that its sole industrial use is for fire wood, but in this it proves satisfactory, giving strong, slow heat and fine coals. Seldom does the live oak grow very tall, the sturdy trunk branching close to the ground.

The new growth of the live oak is attractive to tent caterpillars and these brownish hairy larvae often defoliate portions of the tree. The tents swarming with caterpillars are a common sight each spring. Periodically the live oaks in the San Francisco Bay region are so seriously attacked by another insect that control measures in the form of a spray are instituted. The California oak moth when at its peak of abundance often takes every leaf, leaving the tree a pathetic figure with its bare branches.

Splendid examples of the coast live oak may be found on the campuses of the University of California at Berkeley and of the Leland Stanford Junior University at Palo Alto.

The maul oak is frequently called golden-cupped oak and cañon live oak. Each name is descriptive, but the fuzzy golden yellow acorn cups are indicative of beauty found in the tree itself rather than the usefulness of its wood or the place where it grows. No other oak has the

same golden color beneath the leaf when young, a glow which becomes lead color when the tree is old. No talus is too rocky or barren to prevent the growth of the golden-cupped oak. Often it is the only tree that successfully occupies this niche. The ledges on the granite walls of Sierran cañons give a foothold and roots make use of the smallest of cracks in the rocks. Always does it look thrifty in spite of its meager soil surroundings. Here is an oak that stump-sprouts readily. Sprouts and young trees have leaves so well toothed that one thinks of the true holly. Mature trees have leaves of various types, but many of them have smooth edges. Certainly the toothed ones would be a protection against browsing animals. With so much difference between young and old, one is reminded that, according to a well-known biologic law, the individual lives over, and often indicates, the history of the race. May it not be that the golden-cupped oak in ages past once bore the type of leaves which we find in the new growth? Nearly a dozen different kinds of galls may be found on this oak, some of strange design and rare beauty, each the result of a developing insect.

The wood of this oak is almost as heavy when dry as when green. This weight and the hard, tough, close-grained character of the wood have made it desirable for use in making wooden hammers or mauls. Trees six inches in diameter are selected and sectioned. In addition it is used in practically every other way in which hard oak is used, including furniture and flooring.

A dwarf oak of high elevations in the mountains shows close relationship to the golden-cupped oak even to the color of the acorn cups. Huckleberry oak, because of the similarity of its leaves to those of the huckleberry bush, is scarcely recognized as an oak by the average person unless the tiny acorns are discovered.

In addition to the oaks there is a tree with hard wood

suitable for furniture and inside finishing which, although abundant, seldom grows sufficiently in girth to make it a commercial tree. The California laurel, "pepperwood," or "bay tree," furnished the wood for the doors at the State Capitol at Sacramento as well as a stairway, since removed. The leaves of the tree are shining green and have a strong odor, so strong in fact that the crushed leaves will give one a headache. As a boy in Southern California I helped initiate tenderfoot boys from the East by prescribing ten long whiffs to be taken from crushed laurel leaves. (The second test applied was usually the eating of a ripe olive fresh from the tree.) The leaves are gathered and are much used by housewives as flavoring for soups and dressings. A remarkably large tree of this species grows near Cloverdale on the east side of the Russian River near the bridge. It measures twenty-nine feet in circumference at the ground and fourteen feet six inches at five feet above the ground. The flowers are inconspicuous and the globular fruit also, because colored like the foliage. The roasted nuts were used as food by the Indians, and the white man uses them for feed with which to fatten his hogs.

Those who know or have read of the trailing arbutus, can hardly imagine an arbutus of tree stature; yet the Coast Range of California and to some extent the western slope of the Sierra Nevada harbor a fine tree which bears the name *Arbutus menziesii*. It is, however, only a distant relative of the eastern plant. Its common name is madroña. This is a tree with exquisite texture and color of bark as well as bright red berries. The satiny smoothness of the bark, a rich mahogany-brown color, in old trees is concealed by a darker, heavier outer covering. Trees of six feet to one hundred feet in height are to be found in the north Coast Range. The "Council Madroña," on the Mattole River in Humboldt County, is probably

the largest of its kind in California. Although but seventy-five feet in height, it has a spread in the longest direction of ninety-nine feet. This tree has a girth sixteen inches above the ground of twenty-four feet one and one half inches. Two of its limbs are four feet in diameter. Another fine specimen stands on the south shore of the east arm of Lake Lagunitas in Marin County. At three feet above the ground this tree measures seven feet four inches in diameter.

The madroña reproduces more often by stump-sprouting than by seed. Vigorous sprouts appear whenever a tree is destroyed by fire. The wood is heavy, hard and strong, but checks so badly and is so susceptible to attack by borers that it is not widely used as a hardwood. It does make excellent fuel and is often converted into charcoal. First discovered by the botanist of the Vancouver expedition, it was made known to the world before any other California tree, in 1814. The madroña is widely used as an ornamental tree. Both in color and in foliage it may well lay claim to being one of the handsomest of California trees.

No true hard maples are native to the state and consequently the supply of maple sugar is imported from New England. There are, however, two native maples. The larger one inhabits the banks of rivers and other moist situations. The pioneer Californians soon found that this maple's presence indicated a source of water supply. Stump-sprouting appears to prevent the growth of very large trees as the second growth trunks replace the original one. Perhaps the largest and most perfect tree of this species grows on the Van Arsdale Ranch in southern Mendocino County. The leaves are so large that the tree is usually termed the big-leaf maple or broad-leaf maple. The winged seeds are much like those of other maple trees,

and the leaves are beautiful in the fall, although they seldom take on a red color.

The other native maple seldom grows to be more than a bush, hence the name "dwarf maple." This happens to be the author's favorite shrub. The branchlets are a wonderful red-brown color and the small green leaves are often decorated with bright red spots, either the gall of some insect, or a fungus growth. For daintiness and beauty the dwarf maple is a winner. Another variety, known as the vine maple, inhabits the Coast Range. Its tendency to sprawl rather than stand upright has given it its name.

A near relative of the maple is the box-elder; certainly the winged seeds are similar, although the three-parted leaf should separate it from the maple. Along the stream bottoms this small tree associates with willows and sycamores.

The tall, smooth-barked trees with elm-like leaves which grow along the edge of the streams are alders. The leaves drop while still green; when hung with the pendant catkins as the tree first leaves out, the alder is particularly attractive. The fruiting bodies, two and three in a cluster, look like miniature pine cones. In the high mountains, a dwarf species is known as the mountain alder. The thickets along the stream-side strain the fisherman's patience by impeding progress and catching the fish-line on the back cast.

Of the poplar family there are three members, all dependent upon abundant water, all with heart-shaped leaves which rustle in the breeze because of long stems and unstable equilibrium. The male trees bear flowering catkins which furnish pollen, and the female trees, pendant catkins which furnish cottony seeds carried by the wind. These cottony seeds give some of the trees the name of cottonwood.

The Fremont cottonwood grows along the water courses

where, although often reclining along a stream bank of the lower valleys, it produces abundant shade-giving foliage. The Indian found in its inner bark a suitable fiber for weaving. The bark is often white enough to suggest a birch. The black cottonwood grows tallest, sometimes 125 feet in height. It chooses the cañons from 3,000 to 6,000 feet elevation. The leaves are very pointed and the "cotton" is produced in abundance. With their tufts of cotton the seeds are carried great distances by the wind. When climbing a mountain trail, I have seen them floating a thousand feet above the nearest cottonwood trees.

The quaking aspen grows only on the higher mountains in California, where it chooses the moist situations in the red fir belt and sometimes nearly reaches timber line. The scientific name of *Populus tremuloides* reminds us of the quivering leaves which tremble with the slightest movement of air. The smooth light-colored bark quickly catches the eye, but this is overshadowed by the golden foliage before the leaves fall in October. With the exception of flowering dogwood, no mountain tree takes on more beautiful fall coloring. The quaking aspen is the most widely distributed tree in the world. In Canada, where it is one of the commonest of trees, it has many uses about the farm and furnishes desirable pulp for paper-making.

There are nine species of willows found along California streams. Among thickets of willows the camper finds a place to pitch his tent in a sheltered spot. Willows are distinguished from other trees by the peculiar ear-shaped growths, two in number, at the base of each shoot and leaf stem. Taste may also help to determine a willow, for the bark is bitter. The fuzzy catkins on some species are known as "pussy willows" and appear before the leaves. A red leaf gall often puts a bright color on otherwise dull colored foliage. The various kinds of willows are difficult

to identify. The black willow is a sizable tree found along valley streams. Next to the aspen this is the most widely distributed tree in the United States. One of the white willows known as arroyo willow is most typical of the foothill region. The leaves are pale beneath. From the yellow willow, which grows to tree size and is widely distributed, pioneers made the trees of Mexican saddles.

The California black walnut, the only native representative of the walnut family in the state, has a limited distribution in Southern California and in the Great Valley. Doubt is cast on its existence as a native tree in its northern range. Nowhere does it grow in thick stands but rather as scattered individuals. The wood is valuable when the tree grows to be of merchantable size. A wider use is that of forming suitable roots for budded varieties of English walnuts, the basis of a great industry in California.

First to leaf out in the spring is the California buckeye, sometimes called horse chestnut. Later the conspicuous upright spikes of fragrant bloom attract the attention of every passerby. Travelers along the ridge route north of Los Angeles are sure to ask the first person likely to know: "What are the bushes with candle-like blossoms standing up all over the top?" Only a few of the many flowers mature seeds. The pods containing the beautiful brown seeds with a light spot, hence buckeye, hang on the tree for some time after it has dropped its leaves. Like acorns these seeds contain undesirable properties. Nevertheless native tribes learned to extract the astringent elements and use the ground-up seeds for food. Like many other broad-leaved trees, the buckeye reproduces by stump sprouting as well as by seeds.

The California sycamore catches the eye of every traveler because of its gray mottled bark that stands out against the darker background of vegetation. When

leafless in winter it is especially conspicuous as it looms up along every cañon and wash. Sycamore Park in Los Angeles gives protection to a fine growth of these beautiful trees.

Conspicuous in both the Coast Range and the Sierra Nevada in April and May is the flowering dogwood, often called tree dogwood or mountain dogwood. It may well be called tree dogwood when compared with its bush-like cousin the creek dogwood, which grows in thickets along almost every stream. The large white blossoms among rosetted leaves are very decorative. Examination of this star-shaped flower shows it to be not a true flower at all but a close-set head of small flowers surrounded by a set of white bracts which give the appearance of petals. Southerners often inquire whether our dogwood ever has pink flowers. The answer is no, though they are not always pure white. This tree is no less beautiful when hung with brightly colored autumn leaves. The bitter aromatic bark has been used medicinally.

Stream bank trees of the forested areas include the white alder with its elm-shaped leaves and miniature cone-like fruiting bodies; the black cottonwood which towers above the others and bears numerous fluttering leaves; several species of willows, some sizable trees, others mere bushes; big-leafed maple glorious in color in fall, and the flowering dogwood that draws admiration when it bursts into bloom in late spring. Bare of leaves in winter, these are the trees that furnish green, shady foliage in spring and summer.

In April a tree, sometimes little more than a shrub, becomes covered with fairly large yellow flowers. This tree, limited to California, was named in honor of General John C. Frémont, the early explorer, who discovered it and sent specimens to Washington. Long known as Fremontia, it is now named Fremontodendron. Other names

are false slippery elm, because of the taste of the bark, leatherwood, from the tough fibrous nature of the wood, and flannel bush, from the soft flannel nature of the foliage. The wax-like yellow flowers in April draw the interest of every mountain visitor; the botanist who identifies it is thrilled because no other tree in the United States resembles it and its limited distribution brands it an unusual plant. Yet one does not always have to climb the Sierra to see it, for the beauty of the tree has led to its introduction into many a garden and has made it a tree purchasable at a nursery. In order to end the severe toll of its blossoms taken by mountain visitors, one county of the state has passed an ordinance for its protection.

Trees Used in Landscape Gardening

The planting of trees along California highways has been practiced for many years. Seldom does one find such native trees as the Monterey cypress, live oak, and the California walnut; more often streets and highways are lined with exotics. Originally elms and locusts were brought in from eastern states and maples were occasionally planted. Then Lombardy poplars became the fashion; the landscapes of thirty years ago always contained great rows of these tall trees. A fine row of these trees planted in the early eighties lines the coast highway south of Goleta. For many years eucalyptus plantings prevailed. At present the planting of the European sycamore or plane tree is popular. Occasionally, in the great valleys, one sees a row of beefwoods or she-oaks, natives of Australia. These trees are resistant to alkali and withstand drought. Hence they are to be found in the hottest valleys and on the desert. They have a superficial resemblance to the pines.

The black acacia will make a tree fifteen to twenty feet high in five years' time. Consequently, where rapid growth is wanted it is widely used as a shade tree. The camphor

tree is shapely, and shining light-green leaves and pinkish new growth add to its appearance. Perhaps the largest camphor tree is the one located on Holt Avenue, Pomona.

A tree much admired by tourists and one which furnishes splendid decoration with its berries is the pepper tree (*Schinus molle*). The finely cut drooping leaves, ever green, are most attractive. Another favorite of the southern portion of the state is the umbrella tree, sometimes called the "China tree" because of its origin. Its wide-spreading branches furnish quick shade for the developer of a new homesite. The umbrella tree is successfully grown on the Colorado Desert, as in Imperial Valley. This along with the she-oak are the ones most often used in desert development. Another widely planted tree is named pittosporum because of its pitchy seeds. From Asia and North Africa has come the weeping willow.

Too often trees from Europe, South America or the Orient spoil the harmony of original landscape and often mar its beauty. In California's coastal valleys, the live oak best fits the natural surroundings. The rounded outlines of this tree "are repeated in the soft curves of the foothills." The trees should not be placed in regular rows but irregularly. The treeless stretches of the great interior valleys need quick growing trees that produce shade. Although the valley oak is desirable, such trees as cottonwoods and maples grow faster and give the feeling of coolness and shade. The Digger pine has decorative value and can be grown with a minimum of moisture for a pine tree. It is best suited to the foothill districts. In the semi-desert regions of Southern California a distinctive charm is secured by the use of the California fan palm. A visit to Riverside will soon convince one of the effectiveness of this palm. Yuccas should be used more sparingly. The piñon pine and the desert juniper are very desirable although seldom used.

So extensive has been the planting of exotic trees in landscape gardening that California, and especially Southern California, is a real botanical garden. Even a good botanist may often be puzzled in attempting to identify the trees on some estates. There is space to mention only a few of the better known varieties. In the Capitol grounds at Sacramento, in Kearney Park, Fresno, and along a well-known boulevard in Altadena, may be found splendid examples of the deodar or Indian cedar. This tree has a drooping top and branches and is often cone-shaped with branches touching the ground. The wonderful row of old trees in Altadena is draped with colored lights every Christmas and attracts visitors from a distance. The cedar of Lebanon and the Atlas cedar, close relatives, are less often seen. These three make up the only true cedars known in the whole world; all American trees dubbed "cedars" are not true cedars but belong to the cypress family.

The cedar-like cryptomeria is the main cone-bearing tree of Japan; its symmetrical form of growth makes it a favorite. John Muir once made a trip to Japan to determine whether or not this tree belonged to the same family as the Sequoia. He decided that it did not and botanists have agreed with him.

Golden Gate Park, San Francisco, contains many examples of the European pine, *Pinus pinaster*, a two-needled pine. Other European pines are discoverable. The Colorado blue spruce and several exotic firs are numbered with these cone-bearing trees.

A number of species of araucaria, commonly termed "monkey puzzle trees," are widely planted. One of them, of perfect symmetry, is termed Norfolk Island pine (*Araucaria excelsa*).

The ginkgo or maidenhair tree is a botanical curiosity. It has fruit instead of cones and broad leaves instead of

needles and is deciduous, yet classified with the conifers. The leaves resemble those of the maidenhair fern. Although a native tree of China, it is found nowhere growing in a natural way. Apparently those planted in temple gardens have preserved the tree for our delectation. Judging by fossil remains, it was once a widely spread tree. In recent years splendid fossil leaves have been unearthed along the Columbia River in Oregon.

Italian cypress and English yew are much used in landscape gardening where a tall, slender tree is needed.[1]

From Australia have been imported numerous kinds of eucalypti. The name is derived from Greek words which mean "to cover with a lid." Those who know the interesting buds with their lid-like covering which falls off when the flowers open can appreciate the fitness of the name. The gold rush was hardly over when a traveler brought with him some "gum trees" from Australia. This first and other early introductions had to do with the San Francisco Bay region, the Santa Clara Valley probably first demonstrating the adaptability of this tree. As early as 1865 large plantations were started near Santa Barbara. In more recent years additional interesting varieties including red flowering and pink flowering varieties have been used in landscaping. Probably 100 of the 150 different species have been tried out. Eucalyptus trees are quick growing and produce fire wood at a rapid rate. When cut down they stump-sprout and produce another crop. Eucalypti are likely to be disappointing as shade trees but they are very useful in semi-arid regions in thick plantings in watersheds and as a planting for wood. Although a hard wood, attempts to use it for spokes, furniture and like uses have not been satisfactory. The wood is difficult to season and checks badly. Its use for wood-

[1] *The person interested in exotic trees and shrubs will do well to visit the following botanical gardens: Stanford Arboretum, Palo Alto; University of California Arboretum, Berkeley; State Capitol Grounds, Sacramento; Golden Gate Park, San Francisco; Bard Estate, Hueneme, Ventura County; California Botanical Garden, Los Angeles; Carmelita Park, Pasadena; Balboa Park, San Diego.*

work and furniture is increasing but kiln drying is usually necessary.

Every mining town established soon had plantings of elms and locusts. Another favorite of the pioneer was the oleander, much used in parkings and lawns. Although all parts of the plant are poisonous and although it is much subject to black scale, it has held its place because of the beauty and fragrance of its blossoms.

The magnolia is noted as a tree of ancient lineage and as the tree with the largest and most fragrant of flowers. The bright red seeds, as if dotted in a candle, are almost as attractive as the flowers. Also from eastern states have come the sweetgum, magnificent examples of which are to be found in Chico, and the tulip tree with strange foliage and tulip-shaped flower.

The cork oak, a native of Spain, has been tried with success. The first acorns from this oak arrived in California about 1860. Although the tree has not proved of commercial value, it does make a fine ornament.

The rubber tree, with its large green leaves, native of South America, is best known as a potted tree used for inside decoration. Yet a large one growing at the foot of Chapala Street, Santa Barbara, is evidence that it may grow well in the open.

The carob tree or St. John's bread tree is one of the newer introduced trees in Southern California. Its evergreen leaves and rounded top have helped to hold it in favor. The legume-like fruits are said to be good feed for hogs.

Loquats are ornamental as well as productive of a palatable fruit. The banana with its long leaves is decorative but will not withstand frost, and wind soon ruins its leaves.

The tamarisk is rarely more than a shrub. Its most attractive feature is its bloom of multitudinous pink flowers which grace it once a year. In the Imperial Valley it is

much used as a wind-break to hold the blowing sand, and may some day become a pest as it is very tenacious of life. Meanwhile it is so commonly found that the stranger would think it a native plant.

Utilization and the Future

As the train comes to a stop, the hum of a saw mill is heard. Nearby is the mill pond where men dexterously guide the logs to the incline. Men are pushing cars loaded high with lumber; others are piling it to dry. Freight car loads await shipment. From the box factory come the shooks, neatly tied, on the way to the manufacturer who must box his goods.

Another picture: From some rocky point along the north coast a tramp steamer from Crescent City or Mendocino coast harbor is seen as it steams southward. Soon it will tie up at a wharf where its deck load of lumber will be transferred to railroad cars or piled to await shipment. There are always many fascinated bystanders who watch the derricks and engines swing to shore the neat piles arranged by sweating deckhands. Then comes the ultimate use—in new bungalows, scaffolding or framing for skyscrapers.

We are thrilled at the undiminishing supply as we see it arrive at a coast port. But visit the cutover lands, where desolation reigns. Note the slowness with which old cut areas are reforesting themselves, and another viewpoint appears. How can we use our forests without misusing them? Extensive forests have led to wasteful methods of cutting. Only knowledge of impending calamity has furnished sufficient public interest to improve conditions.

The present stand of merchantable timber in California is placed at three hundred and thirteen billion feet, of which seventy-two billion feet are redwood, the balance being sugar and yellow pine, firs and cedars. This forest

of mature trees covers an area in California of about thirteen million acres. It is estimated that more than two million acres of forest land have already been cut over. An annual cut of one half million feet, with a greater cut in the future, explains the rapid decimation which has taken place. Approximately one third of the merchantable timber is owned by the government and managed by the United States Forest Service; the rest is in private hands.

California uses much of the lumber produced and imports large amounts from the two states just north. In 1919 Southern California in its extensive use of the bungalow used the equivalent of about half the total cut of the state, a per capita consumption of at least twice that of the whole United States. California has long been a center of the export lumber trade. Many boatloads of lumber leave its harbors for foreign countries, and railroads transport quantities to eastern states.

Can a disturbed forest ever return to its virgin condition? Who knows? What we do know is that no return is to be expected within a lifetime or several lifetimes. Certainly even an approximate return to natural conditions means the passing of centuries. Total destruction of a forest usually means consequent removal of soil. Restoration of forest is dependent under such conditions on the slow processes of soil formation and accumulation of humus. Even the trees will not grow until small herbaceous plants give shelter for developing shrubs, and shrubs in turn shelter trees of small water requirements. After all these preliminary steps, we might at last see the growth of trees requiring good soil and moisture conditions such as now make up our forests.

Lest the utilitarian aspect hide other values let it be said that in saving trees we are also saving the very best spiritual and moral forces of the people.

The discussion of trees has covered many pages, for it was difficult to find many trees that did not claim attention because of great size, beauty or unique habit. Yet a number of plants classified as trees have not been mentioned in this chapter, in order to assure reasonable brevity. Still others have been characterized in other chapters. Individual uses of trees fade in comparison with their combined value as forest cover, something to be discussed in another chapter dealing with national forests.

Chapter VII

CHAPTER VII

Finny Favorites

Nothing attracts human nature more powerfully than tempting the unknown with a fishing line.

—Henry Van Dyke.

EVER SINCE the stone age man has interested himself in catching fish, at least for food. Present popularity cannot be measured. One hardly dares to make a guess at the number of men in California who tinker periodically with fishing tackle and talk continually of former experiences along mountain streams.

The wife of a business man could well relate to a neighbor: "A week ago my husband read in the paper that the trout season opens on May first. As a consequence I was unable to drag him to the theatre. He immediately went up to his room, got out his fly book, took his rod out of the case, and began puttering with his reel. Every night since, he has called some friend on the telephone and discussed a contemplated fishing trip and has spent his evenings caressing various favorite flies, oiling up his line, cleaning his reel, and in other ways putting his fishing tackle in order."

The total number of angling enthusiasts in California (both salt-water and fresh-water fishermen) is estimated at 275,000, eighteen per cent of the male population. Pro-

prietors of old book stores can vouch for the keen interest of the angler in both old and new books. "I have nothing worth while now; they keep me cleaned out," is the common remark. Return the next day to find a book that has claimed your interest and it is sure to be gone. Special catalogues of rare books on angling are available. Herbert Hoover can gain plenty of support for his statement: "Man and boy, the American is a fisherman." His conclusion, "The time between bites has become longer and longer and the fish wiser and wiser," has started no end of discussion.

Many authors have attempted to summarize the values to be found in the sport of angling. Outstanding are the following:

1. Angling is the simplest, least artificial, most democratic of sports, yet is a real test of skill.
2. It furnishes an excuse to satisfy longing for open spaces and for the inherent, age-old mystery of water and its inhabitants.
3. It supplies a gambling fascination; there is no sport where the word, "luck," is more often used.
4. It soothes troubled mind and body; puts in good mood.

Herbert Hoover pays this splendid tribute to the sport: "Our stage of civilization is not going to depend upon what we do when we work so much as what we do in our time off. The moral and spiritual forces of our country do not lose ground in the hours we are busy on our jobs—their battle time is the time of leisure. We are organizing the production of leisure. We need better organization of its consumption. We devote vast departments of government and great agencies of commerce and industry, science and invention, to decreasing the hours of work, but we devote comparatively little to improving the hours of re-

creation. We associate joy with leisure. We have great machinery to produce joy, some of it destructive, some of it synthetic, some of it mass-produced. We go to chain theatres and movies; we watch somebody else knock a ball over the fence or kick it over the goal bar. I do that and I believe in it. I do, however, insist that no other organized joy has values comparable to the joy of the out-of-doors. We gain less from the other forms in moral stature, in renewed purpose in life, in kindness, and in all the fishing beatitudes. We gain none of the constructive rejuvenating joy that comes from return to the solemnity, the calm and inspiration, of primitive nature. The joyous rush of the brook, the contemplation of the eternal flow of the stream, the stretch of forest and mountain, all reduce our egotism, soothe our troubles, and shame our wickedness."

The Pacific Coast has long been a Mecca for anglers. California has had a fair share of popularity. Furthermore, many a foreign country has been so interested in the rainbow trout of California that they have begged, and obtained, a supply for their own streams and are now asking for golden trout. Likewise the king salmon, though known largely as a canned product, has formed the basis of enjoyable angling, coveted by others. Not content with its original supply, the state has continually added various valuable food and game fishes from eastern states and from other parts of the world so that a visitor from the Atlantic Coast may enjoy catching his own favorites though they were originally wanting in California streams.

Trout are the peer of all game fish, though some anglers choose other kinds. To the same family belongs the salmon, often named as the most desirable of food and game fishes. Each has an extra fin between the dorsal fin and the tail which is known as an adipose fin. The family

name, Salmonidae, means "the leapers." Many members of this family are notable migrants and only sizable obstructions block their upstream trip to spawning ground. Salmon in Alaska have been known to travel more than a thousand miles up the Yukon River, and in California king salmon once found spawning grounds at the heads of the longest rivers, the Sacramento and the San Joaquin. Few fish perform greater migrations in fresh water.

Salmon

Of the five salmon known along the Pacific Coast, four have been taken in California streams. The humpback and dog salmon are not numerous and are less well known than the king salmon and the silver salmon. Because of its remarkable life history, the king salmon is known to biologists throughout the world. Few animals there are of which it can be said, "The young never see the parents and the parents never see the young."

The king salmon, both male and female, make their way to suitable spawning grounds at the heads of the larger rivers, but after spawning they die, leaving the whole future of that particular family to the eggs left in the gravel on a riffle bar.

When someone suggested that the salmon was an anadromous fish, one that spends part of its time in fresh water and part of its time in salt water, few would believe it. Finally the California Fish and Game Commission carried out an experiment which demonstrated that young salmon could live just as well in salt water as in fresh water. Several hundred young salmon were placed in a "live car," a simple cage capable of being towed through the water. Starting at Sacramento these small fish were towed down the Sacramento River behind a launch. On arriving in the salt water of San Francisco Bay, they seemed to be quite as happy as when held in fresh water.

In brief, the remarkable life history of the king salmon is as follows: The young fish on hatching from the eggs wriggle out of the gravel and spend a month of their lives in shallow water lying on their sides and taking no food. Attached to the underside of each baby salmon is a sack of food material. This appendage prevents rapid movement, but it furnishes a supply of food so that the baby fish does not have to search for it. After about a month the small fish begin swimming in the current, remaining largely in shallow water away from the larger fishes which might eat them. Life in the fresh-water stream is temporarily terminated about six months after hatching, at which time these small fish have slowly drifted down the river, always with heads in the current, until they have reached the open ocean. The next three years of life are largely clouded in mystery. A few one-year-old and two-year-old king salmon have been taken in coastal bays, but where the great mass of these fish find feeding grounds is still unknown. Certainly half-grown salmon are seldom taken in fishermen's nets. In the spring of the fourth year full-grown salmon appear in numbers in the larger bays and at the mouths of the larger rivers. They enter these streams during the late spring freshets, and fighting their way against the current and surmounting waterfalls they travel hundreds of miles upstream. During this period of life in a fresh-water stream they take no food, as is evidenced by the empty stomach and by the fact that they are not interested in a baited hook. When still in salt water, while waiting to go up stream, they appear ravenously hungry and are easily taken with hook and line. A large part of the salmon sent to market is taken on hook and line in Monterey Bay or along the Northern California coast.

On reaching suitable spawning grounds the females, which may weigh 40 to 60 pounds, dig out a trench in the

gravel on a riffle bar. Here some 5,000 eggs are extruded. The female is accompanied by a male. The eggs are externally fertilized and are covered with gravel. After spawning, both the female and male drift down the river as "spent" fish. The males often have distorted jaws, and both sexes may be covered with white patches of fungus. Before long both are barely able to hold their position against the current and soon their dead bodies float out on the bank to be eaten by predatory animals.

No fish in the whole world has a more remarkable life history: a combination of life in both fresh and salt water, a notable migratory instinct, and final death at the age of four years. Occasionally, salmon develop and return to the fresh-water streams at an earlier age, but females return almost invariably at four years of age.

Nor is this all of the story, for in recent years scientists have proved the "parent stream theory," one which suggested that the salmon always returns to the same stream in which it was born. The California Fish and Game Commission has been making life history studies of the king salmon for a number of years. This work, directed by Professor John O. Snyder of Stanford University, has brought to light many facts regarding the age, rate of growth, and migratory habits of the king salmon. In one experiment, eggs from Klamath River salmon were hatched, the young fish marked and liberated in the Sacramento River. Conversely, eggs of Sacramento River salmon were hatched and the resultant marked fish liberated in the Klamath River. Four years later the marked fish captured were in each instance found in the same stream in which they were liberated, proving that it was not an hereditary instinct bound up in the egg, but was perhaps acquired taste or knowledge of the stream in which the fish lived when young.

In recent years it has been shown that the scales of some

fishes show annual rings of growth much as do trees. Studies of these rings of growth on salmon scales have proved conclusively that the king salmon reaches the open ocean at about six months of age and returns to fresh water to spawn at about four years of age. Furthermore, no salmon scale has shown evidence that any salmon has lived after spawning.

In spite of the fact that salmon do not take food on their migration up stream they are often caught by anglers, though seldom on a baited hook. They do strike viciously at a spoon supposedly because of pugnacity and a desire to drive a small fish out of their way rather than a desire for food. Salmon after they have reached their spawning grounds are not very desirable for food, because of their emaciated condition. They are still less desirable after spawning. Furthermore, when high in a mountain stream they appear to have lost much of their vivacity and it is tame sport to land even a large salmon. The same fish in tide water is gamy and makes a very worth-while prize.

In many coastal streams young salmon are confused with steelhead trout and migratory species of trout. A young silverside salmon weighing two or three pounds runs commonly in coastal streams where it is known as "grilse," a word sometimes contracted to "grill." These salmon grilse are appreciated both from a standpoint of sport and of food. They may be distinguished from trout by the shape of the anal fin and by the constricted base of the tail. The anal fin of a trout when pressed against the underside of the fish reaches beyond the basal attachment of the fin, whereas in the salmon it does not.

Unlike the king salmon the silverside may spawn several times before it dies. The meat of this salmon is not so red in color nor does the fish grow so large. As a consequence, the silverside is not so highly prized.

The future of the king salmon does not look bright. There has been constant diminution in numbers, though one cycle of increased abundance is to be noted. Originally one of the most abundant of fishes and the basis of the greatest canning industry in the state, it is becoming scarce and the industry has been on the wane in this state for many years. The first notable diminution came after the period of hydraulic mining. Supposedly the great amount of silt thrown down into the mountain streams created an unfavorable condition for the salmon. After hydraulic mining was stopped, salmon appeared to increase. In more recent years the combination of insurmountable dams which block these migratory fish from their breeding grounds, oil, and other pollution, has been responsible for diminished numbers.

The best, and the last great run of king salmon left in the state is to be found in the Klamath River. Had the people of the state not rallied in opposition to the building of two high dams near the mouth of this river, this too would have gone. No fishway yet devised will successfully carry a salmon over a dam more than 40 feet in height and should artificial means be discovered to carry the adult fish over such artificial obstructions, it is doubtful whether any means could be devised for aiding the young fish to descend the dam on their journey downstream to the sea. There are certain natural resources which are far more valuable than any handiwork of man. When people are hoodwinked into believing that the brains of man can build artificial structures more useful to civilization than raw materials represented by natural resources, danger is ahead. Works of man may be built and destroyed at will, but there is yet to be found a man who can create a natural resource such as is represented in fish life.

Fishermen would still be dependent upon "fish stories"

for their information regarding the fish of this state had not Stanford University specialized on this subject for many years. Now numerous reports on the various California fishes make worth-while information available.

Trout

Native to the streams and lakes of California are four types of trout: cut-throat, steelhead, rainbow, and charr.

The commonest trout in the mountainous region of North America has reddish markings under the gills which give it the name cut-throat trout. Its large black spots, well scattered, have given it another name of black-spotted trout. In California, cut-throat trout are chiefly limited to the larger mountain lakes from Tahoe northward. The most notable cut-throat trout in California is a large one found in Lake Tahoe and nearby lakes of the Truckee Basin. In Lake Tahoe it grows to considerable size, where it is a deep water fish and is usually caught by means of a long copper line wound on a small windlass at the back of a boat. However, the fish enters tributary streams to spawn or lays its eggs on sandbars in the lake. It is occasionally found in shallower water during the summer season where it seems to be attracted by the minnows. At this time it may occasionally be taken with a fly from the shore. Because of its late period of spawning, the open season on this fish in tributary streams has been set late to avoid the capture of spawning fish. In years past it was common for Indians to procure these fish from smaller streams by means of pitchforks. They could even be caught by hand.

In the whole Truckee Basin of east central California conditions have been favorable for trout and this region has long been attractive to the angler. Originally, before it was blocked by dams, there were great runs of trout from Pyramid Lake up the Truckee River, the outlet of

Lake Tahoe. These migrations are the most notable of any performed by stream or lake trout in California. The fish concerned in these various runs received names according to their appearance. The larger redfish with bright iridescent colors ran early in the spring; the smaller "tommy," darker, and more conspicuously spotted, ran at a later date. A silvery colored trout with less conspicuous black spots than the well known Tahoe trout was known as silver trout. The Truckee trout is the resident fish of the river and the emerald trout of Pyramid Lake. A study of these various trout, made by Dr. John O. Snyder of Stanford University, brought out the fact that redfish, "tommy" and silver trout are all variations of the Tahoe trout *Salmo henshawi*, often known as black-spotted trout.

Another trout native to Lake Tahoe and found only in deep water along the eastern side has been named the royal silver trout, *Salmo regalis*. Spotting is found only on certain fins and there it is very inconspicuous. The back is a beautiful steel blue and the under side is white. It differs structurally from the Tahoe trout as well. The royal silver trout is not a common fish and may be considered a rarity as compared with the common Tahoe trout. Little is known about its habits. Apparently it does not spawn in tributary streams. Fishermen secure this beautiful fish by fishing deep along the Nevada shore of the Lake.

The steelhead trout grows the largest of any native California trout, occasionally reaching a weight of more than twenty pounds. This trout more than any other is distinctly migratory and whenever possible spends part of each year in salt water. Notable migrations take place during the spring freshets in every coastal stream of any size from the Oregon line to the Mexican line. Devotees of steelhead fishing are ready to challenge anyone to find a gamier trout. After being hooked it often leaps clear of the water several times and fights long and hard.

The fish usually termed a steelhead enters the coastal streams in a periodical migration in summer and early fall. Fish appear at the end of July and are abundant by August and September. Their appearance in numbers draws thousands of anglers to the Eel and Klamath rivers. In tide-water where they usually stay for a time, their backs are steely blue. The upper fins are always spotted and sometimes the upper part of the body. The sides are silvery. That they come directly from the sea is proved also by the presence of marine crustaceans often found attached to their bodies. Some reach the headwaters of the main stream and its tributaries where they spawn the following spring. Meantime they assume nuptial colors and look very much like the non-migratory forms usually called rainbows. Even estuary forms show pinkish cheeks and reddish stripes on the sides. Studies of the age and rate of growth by means of scales support this view. In fact, the latest view of such students as Dr. David Starr Jordan and Dr. John O. Snyder is that rainbow and coarse-scaled steelhead are one and the same species, some individuals running to sea and returning as large silvery colored fish.

Even though students of fishes may disagree, steelhead is a proper term to apply to sea-run forms, though we may well apply the scientific name *Salmo irideus* to both stream and ocean-going forms.

It is surprising to see what small coastal streams these trout will enter and what ability they show in negotiating waterfalls and other obstructions. Sometimes their entrance to a fresh-water stream tempts these fish to show their exuberance by leaping high out of the water and falling back with a great splash. Many steelhead, as proved by study of the scales, spend a year or more in a fresh-water stream before going to the ocean. Then they may return annually to spawn. The well-known half-

pounder of the Eel River which has been responsible for much speculation by the angler, has been shown to be a three-year-old male steelhead on its first spawning migration. These smaller fish are present in the lower reaches of the streams in considerable numbers from the first of October to the middle of November or until high water permits them to migrate upstream. They afford fine sport and are much sought after, but should receive careful protection in that these younger fish have not yet spawned and if successful will return in following years as much larger fish with far greater egg-laying capacity.

Although any trout with pinkish flesh is likely to be termed a "salmon trout," the steelhead is the fish most often given this name in California. A market fisherman usually separates the steelhead from the salmon by noting whether it can readily be held up by the tail. The constricted base of the tail in the salmon makes holding easy, whereas the flabby tail-fin of the trout makes holding difficult. When in the hand the two are easily separated on the basis of teeth, number of rays in dorsal fin and shape of anal fin. An expert is needed to identify them beneath the water.

Many a fish caught in tidewater on the Eel River or the Klamath weighs ten pounds and tasks the skill of the angler to land it. Very prolific, each large female lays from two to three thousand eggs. Unlike the king salmon, the steelhead spawns several years in succession. Some that have been marked at spawning stations have been retaken three years in succession.

The steelhead is an important fish in fish cultural operations in California. A large number of eggs are secured at spawning stations situated on coastal streams. Steelhead planted in high mountain lakes where they are landlocked retain many of their characteristics, but apparently do not reproduce. This species has been introduced

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into Lake Superior and is now a highly prized game fish in that lake.

The rainbow trout is famous the world over. New Zealand and the Argentine Republic, as well as many an eastern state, boast of rainbow trout, the original stock having been obtained in California. The common native trout in mountain streams throughout California has beautiful iridescent colors along its sides which have given it its name. Perhaps the most typical and certainly the one most widely distributed outside the state is the native fish of the McCloud River. This, along with other rainbow trout, is a fish of a rushing mountain torrent in a granite-walled cañon. It demands pure cold water, well aerated. The females seldom produce eggs until the third season, but males are good breeders at two years of age. Largely an insect feeder, this is the fish par excellence of the fly fisherman. No other western trout of equal weight seems to compare with it in gaminess. Its meat is usually white and very sweet. Its color lends added attractiveness. That the rainbow is not a fussy feeder is attested by the wide variety of baits which have taken fish and also by actual stomach contents. There is a basis for the stories relative to bacon rind and mice serving as attractive bait. Furthermore, from stomachs have been taken mice of various kinds and birds as well. Vegetarian habits are displayed through the finding of berries of various sorts and mountain ash berries are often termed "fish berries" for a very good reason. Cannibalism is not confined to the taking of other kinds of fish but includes their own kind.

From the mountains of Lower California to the Shasta region there are no less than five named varieties, all belonging to the series of rainbow trout. Slight differences in numbers of scales and in coloration have given rise to the separation.

The golden trout originally found only in the headwaters of the Kern River in the vicinity of Mt. Whitney is considered the most beautiful trout in the whole world. The Kern River itself contains a beautiful rainbow and it is thought that the three varieties of golden trout found in its headwaters are varieties developed by isolation. Lava flows might well have been responsible for isolating fish in the headwaters of Volcano Creek. In other streams trout may have been isolated because of high impassable waterfalls. At any rate, different environments appear to have modified and differentiated the fishes of several headwater streams.

In 1903, according to Dr. Barton W. Evermann, Stewart Edward White, impressed with the possibility of extermination of these trout, wrote to George M. Bowers the Commissioner of Fisheries and to the President of the United States, calling their attention to the matter, and on July 13, 1904, Barton Warren Evermann, Assistant in Charge of the Division of Scientific Inquiry, Bureau of Fisheries, with a party, outfitted at Redstone Park, Tulare County, and left for the Whitney country to investigate the trout of the Kern River region. As a result of the investigation, the true golden trout of Volcano Creek was recognized as a new species, and was named after the naturalist, Theodore Roosevelt, who at that time was President of the United States.

The United States Bureau of Fisheries made an extended study of this trout, and in 1905 an attempt was made to establish a temporary hatchery station on Volcano Creek in order that the eggs of the golden trout might be obtained. But the spawning season was over before operations could be started. Now a state hatchery specializes on the rearing of this species.

Although California has been generous with the rainbow trout and has furnished it to the world, she has con-

sistently refused to ship golden trout to other states. It seems only reasonable that a few distinctive California resources should remain the sole property of this state. However, the species has been widely distributed through the southern Sierra.

The earliest record of distribution goes back to 1876 when the Stevens brothers, who had built a small sawmill on Cottonwood Creek, saw to it that the stream was well stocked with golden trout for their own use. The supply came from Mulkey Creek in Mulkey Meadows and the fish were in all probability the South Fork golden trout. In the same year a Mr. Wiley Watson brought some golden trout from the Little Kern, via Farewell Gap, and planted them in the stream at Mineral King, so that a sufficient supply was available until later plantings in 1894. New plantings were continued by various individuals during the nineties. Live fish were first exhibited to the public at the Mid-Winter Fair in San Francisco in 1892. In 1908 the Sierra Club made numerous plants, using in each case two ten-gallon cans especially designed for the work. Beginning in 1909 and lasting for several years, the California Fish and Game Commission made a wide distribution of golden trout. Some of them were even taken across the summit via Kearsarge Pass and other shipments made to various tributaries of the Kings River. In more recent years golden trout have been planted as far north as the Yosemite National Park. At present the golden trout is found in many streams, even 150 miles north of its original home.

Not only is a golden trout magnificently colored, but it is a fine gamy fish and its richly colored flesh is likewise tempting. Bright colors are not assumed until the individual is four to five inches long. Because of its uniqueness, this fish is given a shorter open season than other trout. It spawns late and to protect it on its spawning

grounds, the season does not open until mid-summer. Furthermore, a limit of twenty is set as well as a size limit of five inches. No other trout in California has the distinction of a size limit.

The name, Dolly Varden trout, appears to tickle the ear of anglers as there is no name they like to apply as often as this one. Fish caught in the middle Sierra and dubbed Dolly Varden, are in reality Eastern brook trout. The true Dolly Varden is limited to the McCloud River in this state. The naming of this fish is of interest. David Starr Jordan and a party of friends were camping on the McCloud River when someone brought in a beautiful fish with large reddish spots on its sides. A woman member of the party suggested that the spotting looked like Dolly Varden cloth, a polka-dotted dress goods which was in vogue at that time. Jordan thereupon dubbed the trout Dolly Varden. Anglers of Oregon despise this fish because they consider it a voracious, predatory species. It is given no protection in that state. As a rule, it lives at the bottom and when hooked puts up a poor fight. The fish is even said to attempt to defend itself by biting after it is taken from the water. Perhaps California is fortunate that this fish is not more widely distributed. At any rate, any reports as to the taking of the Dolly Varden elsewhere than in the McCloud River, in California, are apt to be erroneous.

As a result of California's interest in fish propagation and acclimatization, the state now possesses four species of trout that are not native to California streams. The one most widely spread in the mountain districts, but never found in coastal streams, is the eastern brook trout. This fish has apparently fitted into a niche not occupied by the native rainbow trout. It appears to choose the smoother moving cool streams of high mountain meadows

and prefers sluggish pools to fast running water. This fish furnishes excellent sport as it takes the fly readily.

The eastern brook trout is one of the most beautiful of game fish. Technically, it is called a charr rather than a trout because of its blood-red spots. A beautiful marbled effect on the back is characteristic and most anglers recognize the fish even in the water by its reddish brown fins tipped with white. The meat is softer than that of the rainbow, but fine grained and very sweet. Many that have a pinkish flesh are taken, especially those living in lakes. This does not represent a different species of fish but is probably caused by a diet of crustaceans. In lakes, eastern brook trout grow to a fair size, even reaching three or four pounds, but these lake fish are less desirable for food because they usually have a weedy taste.

Though the eastern brook trout thrives in the cold water of the high mountain meadows and lakes, it has never become acclimated in a coastal stream in this state. Seldom, in California, is it found in fast rushing streams. The largest brook trout are found in the deep, wide pools in the warmer waters; the smallest ones are found in the cold, narrow mountain rivulets near their source. Eastern brook trout do not keep well nor ship well, probably on account of the fat. They spawn high up in the tributary streams and so early (October to January) that eggs for hatchery purposes are almost impossible to obtain.

The California Fish Commission purchased 6,000 eastern brook trout in 1872, and distributed them equally in the North Fork of the American River, in the headwaters of Alameda Creek, and in the San Andreas reservoir, near San Francisco. In 1875, a large shipment of eggs, 60,000, was received from New Hampshire and succeeding shipments in 1877, 1878, and 1879. Beginning in 1890, large numbers have been hatched and distributed each year. More recently, eggs for the hatcheries have been secured

from the Marlette-Carson hatchery in Nevada, and from Utah.

In 1894, 100,000 eggs of the Great Lakes or Mackinaw trout were secured and hatched successfully. In May, 1895, 65,000 Mackinaw trout fry were placed in Lake Tahoe and later the same species was planted in other lakes of the Truckee Basin. This native of lakes Superior, Huron and Michigan attains a very large size. It is a long-headed trout and a voracious feeder. It has a decidedly forked tail and the entire body is spotted with white. Though this species has never appeared in very great numbers in Lake Tahoe and neighboring lakes, yet some are taken every year. It is not unusual to have reports of fish weighing more than 20 pounds. One taken at Homewood on Lake Tahoe in the spring of 1924 weighed 32½ pounds. As a rule, they are taken in deep water with spoons.

In the same year that the Mackinaw trout were planted in California streams, 20,000 eggs of the Loch Leven trout, a trout of Scotch Lakes, were secured from the United States Fish Commission, and stock of this wonderfully spotted fish has since been maintained at the Mt. Shasta Hatchery. Thousands of eggs are obtained each year and the fish have been planted in many streams.

Some scientists consider the Loch Leven trout but a slight variant from the brown trout of Europe. Eggs of the German brown or Von Behr trout were secured in 1895; though previous to this the Federal government had made several plants in the state.

Though many anglers are inclined to label these European introductions as predatory and undesirable, it is doubtful whether any trout is more cannibalistic than our native rainbow. Rainbows will not thrive in polluted or warm streams. The European trout does succeed in living under these conditions. In some of our streams in the foot-

hills the brown trout helps to furnish good sport where otherwise no sport would be available. Furthermore, in fish propagation work these species are easy to handle as compared with native trout.

Although the California fishery experts have had wonderful success in the introduction of these exotic species of trout, several other attempts at introduction of game fish have proved failures. At least six attempts have been made to introduce the landlocked salmon without tangible results. Several thousand Montana graylings have been introduced in the various streams without being successfully acclimated. It is probably to the advantage of the state that the muskallunge did not thrive when placed in Lake Merced near San Francisco. Had this famous eastern game fish become acclimatized it might have given endless trouble because of its predacious habits.

Other Game Fish

Thus far, mention has been made of salmon and trout only. Native to the larger streams are two other fish which come under the observation of sportsmen because they take a fly. Many a man describes a sizable fish which he is sure is not a trout but which he has caught on a fly. When such a fish is submitted for identification it usually proves to be the largest of minnows, the Sacramento pike or squawfish. This fish was widely used by California Indians for food and many a white man has found it palatable. Not all minnows are small fish as may be proved by catching a three or four foot squawfish. Certainly it is large enough to please the average angler. The lack of an adipose fin between the dorsal fin and the tail, and the large mouth without teeth help in identification. This fish is very numerous in some streams and some anglers are accustomed to blame it for the disappearance of trout, maintaining that this fish eats its eggs and young. For

many years anglers of Monterey County have complained of the Sacramento pike found in their streams and the coincident scarcity of trout. Probably some other reason for decrease will come nearer explaining the situation.

The native whitefish is found only in Tahoe Basin. Several attempts to introduce the whitefish of the eastern United States have proved failures. A million and a half eastern whitefish were introduced between 1872 and 1883 but they did not thrive. In some streams, as for instance the Feather River and the Merced, is a small-mouthed fish that is sometimes taken on a fly and termed "whitefish." Usually it proves to be a "hardhead" or "splittail," members of the minnow family.

One other native fish of the larger rivers is the Sacramento perch, the only perch-like fish native to California fresh-water streams. Here again is a fish which is a favorite of those who know how to catch it with flies. The flesh is white and delicious.

The eastern angler who tries his luck in the lakes and streams of California takes it as a matter of course that he will find two kinds of black bass, three kinds of catfish, several species of perch and sunfish and the famous striped bass. To most it would seem unbelievable that all of these fish are non-native and have been introduced, but such is the case. The small-mouthed black bass arrived in California in 1874 when a number of adult fish were planted in Alameda Creek. Five years later twenty-two adult fish were planted in Crystal Springs Reservoir in San Mateo County, whence they have been distributed widely over the State. It was not until 1891 that 2,000 one-year-old large-mouthed black bass were planted in Lake Cuyamaca in San Diego County and 620 in the Feather River near Gridley. Since then several hundred other plants have been made and these two bass are highly esteemed and have proved great acquisitions. The

black bass are the best fish for reservoirs and warm water lakes. However, too often these voracious fish have been planted in lakes containing trout with the result that the trout disappear. The surreptitious introduction of the black bass into Big Bear Lake, a famous fishing resort of Southern California, is a menace to the future of trout fishing there.

Black bass are abundant in the lower reaches of the Sacramento and San Joaquin rivers and tributary sloughs. In numerous reservoirs where the water gets too warm for trout, black bass have been placed. The angler appreciates the gaminess of this fish sufficiently to overlook the one great criticism: "Could not get a bite, though yesterday I made a fine catch." The erratic habits of black bass are difficult to explain. Certain it is, there are days when the most skilled have no luck. At other times the fish seem ready to strike at any sort of a lure. No other fresh-water fish fights so hard and so long after being hooked.

Many small black bass find feeding grounds in overflowed areas with the result that in past years thousands were lost when the water dried up. Now the fish for stocking are obtained by seining these areas. No attempt to propagate bass in the hatcheries has been made.

Striped Bass

The introduction of striped bass in 1879 has proved to be the most successful and important of any. Of fish collected in the Navesink River, New Jersey, 135 of various sizes from one and one-half inches to full-grown fish were placed in the Carquinez Straits near Martinez. The only other plant was in 1882 when three hundred striped bass were secured from the Shrewsbury River, New Jersey, and deposited in Suisun Bay near Army Point.

Increase in size was noticeable in the catches of succeed-

ing years. In September, 1883, a 17-pound striped bass was taken at Monterey Bay. The following month a 16-pound fish was caught in the Sacramento River. On March 11, 1884, an 18½-pounder was offered for sale in the San Francisco market. Ten years after planting, on June 16, 1889, a 45-pound striped bass was sold on the San Francisco market.

In 1889, hundreds of striped bass weighing from one half to a pound each were being caught and sold in the San Francisco markets. From 1889 to 1892, the number caught had increased 250 per cent. After 1900 they were occasionally taken in tributary streams. Previous to 1903 striped bass weighing twelve pounds were taken in the Feather River near Oroville and were numerous in the Tuolumne River above Modesto, in the Stanislaus and in the Merced and San Joaquin rivers. In the Sacramento River striped bass have been taken as far north as Kennett.

For many years there was no great extension of range along the coast. Striped bass were limited largely to the Sacramento and San Joaquin rivers, with occasional specimens being taken from Monterey Bay northward as far as the mouth of Russian River in Sonoma County. By 1896 this fish was fairly abundant in the mouth of Salinas River; a few years later it was taken in the coastal streams of Oregon, and in the fall of 1906, a half dozen specimens were secured by the U. S. Bureau of Fisheries in traps at the mouth of the Columbia River. In 1925 striped bass were being caught in commercial quantities in the Coos Bay region, Oregon, and dealers at Big Bend, Oregon, were looking for a market for these fish in California.

Considering the small number of fish introduced and their remarkable increase in a few years, the result obtained from the introduction of the striped bass into California is one of the greatest feats of acclimatization of new species of fish in the history of fish culture.

With an original outlay of less than a thousand dollars, the state has furnished a fishery which yields more than a million and a half pounds valued at a half million dollars annually, and at the same time has furnished anglers of the state one of their best attractions. Since this successful introduction, more than 2,000,000 pounds of striped bass have sometimes been marketed in San Francisco during a single season besides the fish sold elsewhere.

Wishing to furnish the northern coast counties with this most desirable food fish, an attempt was made in 1899 to introduce the striped bass into the streams entering Humboldt Bay. Most of the shipment died en route and less than a dozen were actually planted. Whether or not this plant was successful is not known, but three or four specimens were secured in the Eel River ranging as high as twenty pounds in weight in 1907, and an occasional bass is taken in Klamath River to the north.

In 1903 seventy-five bass six inches long to three and one half pounds in weight were planted in brackish lagoons at the mouth of the Santa Ana River in Orange County. Another plant was made the following year. Finally a carload of striped bass ranging from six inches in length to four pounds in weight was collected in 1909 in the Straits of Carquinez, at Port Costa, within two miles of where the original plant of bass was made twenty-seven years before, and, without loss of a single fish, distributed in suitable waters in Orange County. This third shipment made into these waters within eight years was expected to determine beyond all question their adaptability to the conditions found there.

On October 26, 1916, eighteen hundred small striped bass were planted near the mouth of San Diego River by the Fish and Game Commission. Morro Bay, San Luis Obispo County, received a plant in 1919. Since then

striped bass have been occasionally seen near the places of planting.

Although known to be an anadromous fish, the striped bass is to be found in the San Francisco Bay region or in the lower Sacramento or San Joaquin rivers in varying numbers in any month of the year. In the lower rivers, however, more of them are caught in the spring and autumn.

There are two distinct migrations of the striped bass. In the spring, beginning during March and extending through April, May, and part of June, the spawning migration takes place. They come from the deeper holes in the lower rivers and bays, also from the ocean, and run well up the Sacramento and San Joaquin rivers and some of the smaller tributaries like Napa River.

In the fall of the year the run of what is known as "winter bass" takes place. The fish of this run are frequently immature bass, often not over five or six pounds, and, according to the fishermen, are bright and fresh from the sea. They come into the bays, run into the sloughs and for some distance up the rivers for the purpose of feeding. Some of these bass may be with spawn, but the eggs probably are not deposited until after March when the water temperature gets above sixty degrees. This fall run commences usually in September, the time being somewhat variable, and lasts from two weeks to two months.

Record striped bass at present usually weigh between fifty and sixty pounds although about 1910 two were reported which weighed over seventy pounds. Such fish are well over four feet in length. The food of the adult striped bass in the rivers is principally carp, hardheads and splittails. Nearly all the fishermen claim that when the carp is plentiful it is their principal food. Other small fish and crabs may be found in their stomachs.

Every fisherman knows that striped bass are very spo-

radic in their occurrence and that in a place where large catches have been made one day the fish are not to be found the next. As supposedly, the same school of fish remains in the same pools to feed each day, even though there may be a daily migration with the tides, inability to catch fish with hook and line is not always an indication of "no fish," but may be only an indication that they are not feeding. The movements of striped bass in a stream are not definitely known and much is still to be learned regarding feeding preferences.

Along the Pacific Coast the striped bass is most often caught in the bays near mouths of rivers, in sloughs and slow-moving streams. To the angler it is "a gallant fish and a bold biter." It is eagerly sought by a host of anglers because of the excellent sport offered in its capture as well as the delectable white meat so desirable as food.

Night fishing has been much in vogue, but this fish is such an erratic biter that there is no definite proof that fishing is much better during hours of darkness. Legal restrictions have put commercial night fishing under the ban.

Most anglers claim fishing becomes poorer in streams and sloughs during cold or stormy weather. The fish are supposed to seek the deeper pools at the mouths of streams at such times.

Striped bass take the hook savagely, make runs and sometimes leap from the water, shaking themselves to be rid of the hook. Then they often go to the bottom to sulk. However, the runs of this fish are not so formidable and persistent as those of the steelhead trout and salmon, and it is more easily brought to gaff.

In California the same tackle is ordinarily used as is used for salmon. Trolling usually gives the best results in brackish water, but many are taken from the banks of sloughs with hand lines or casting rods. A heavy sinker

keeps the hook near the bottom. Bait hooks, plugs and spinners are used. Squid is one of the favorite baits.

Next to the trout the striped bass is unquestionably the most popular game fish of Northern California. At certain times of the year, Bakers' Beach, San Francisco, is lined with surf casters. Anglers loaded with equipment crowd the trains which carry them to the upper parts of the bay. Every Sunday, Cutters' Wharf on the Napa River parks hundreds of automobiles belonging to striped bass fishermen. Famous old fishing grounds include San Antonio Slough near Petaluma, Oakland Estuary, San Leandro Bay, and Petaluma Creek at Schultz's. Cache Slough and Prospect Slough on the Lower Sacramento River were at one time famous striped bass fishing grounds. In more recent years, Elkhorn Slough on Monterey Bay near Watsonville has furnished excellent sport.

Bait casting as a sport is becoming increasingly popular because of the skill required. Large striped bass fishermen's clubs exist in the large cities in order that the numerous devotees of the sport may get together for discussion. To the men satisfied with patient sitting and waiting for a bite or with trolling from a boat the black bass and striped bass appeal. Like the trout, their wariness and fighting qualities, with the additional advantage of tastiness, have been responsible for their favorable reputation. It takes perseverance and patience to make a good bass fisherman.

Shad

The first attempted introduction of any food fish, that of the shad, a notable fish of eastern streams, makes a story of many difficulties. On June 19, 1871, about 10,000 shad fry arrived in Sacramento and were hastily planted in the Sacramento River at Tehama. The successful transportation of these fry in a specially equipped aquarium

car, the property of the United States Fish Commission, led to an ill-fated attempt at another introduction in 1873. This car, containing nearly 300,000 valuable food and game fish of ten different varieties, was lost through the collapse of a railroad bridge over the Elkhorn River in Nebraska. Another shipment was ordered and 35,000 more shad were planted in the Sacramento River near Tehama. In 1873, only two years after the first planting, several mature shad were taken in San Francisco Bay. This fish continued to increase until it became one of the commonest fish in the Sacramento and San Joaquin rivers.

Though planked shad is considered the greatest of delicacies in the East, the shad of California has never proved very popular. For many years only the Chinese caught this fish. They dried it in large numbers, and shipped the dried fish to China. In more recent years, since the supply in eastern streams has greatly diminished, a market has grown up in eastern states which takes about ninety-five per cent of the total catch in California. The roe from the female fish commands a high price and is shipped in large containers. A man who walks down to the water-front in Philadelphia and asks for a shad pays about $1.25 for a small three-pounder. If he should ask the market man if the shad he has purchased came from the Delaware River, he would be informed: "No, that shad came from Pittsburg, California." The lover of fish foods who may wander into a fresh fish market in San Francisco may often pick out a fine large four-pound shad and purchase it for 25 cents. Though the shad is considered a luxury in eastern states, there are few Californians who appreciate its food value. The shad is admittedly bony, but bones can be removed and certainly there is no fish that has whiter or sweeter meat. The housewife in California continues to choose halibut, salmon or striped bass at three and four times the price per pound of the shad, yet to a

connoisseur, the shad is the more desirable fish. Along the rivers of the great valleys dip nets are used by residents to obtain shad as food and many consider this method of taking good sport.

Though striped bass and shad furnish the most spectacular stories of acclimatization, mention should be made of the success attendant upon the introduction of the carp, the crappie, the blue-gilled sunfish, and the yellow perch. The carp, now an exceedingly common fish, is despised by all except Chinese and Japanese, because of its muddy flavor and its many bones. The crappie has proved a splendid food fish in the interior valleys and furnishes good sport to the fly fisherman. The yellow perch and blue-gilled sunfish are smaller and less well known, but nevertheless are valuable adjuncts to the fishery resources of California.

Another fish, one tiny in size, has been placed in the waters of this state, not to furnish sport but to help in the control of disease. Until recently, energy was exerted in attempting to destroy malaria germs within the body of an afflicted person. In more recent years emphasis has been placed upon prevention rather than cure. A small top minnow, *Gambusia*, has been widely distributed. Tenacious of life, it thrives in stagnant pools where mosquito larvae develop. This same little fish has been introduced with success into Hawaii, Formosa, the Philippines, Spain and Italy. Everywhere it is heralded as a valuable destroyer of disease-carrying mosquitoes.

Sport Fishing at Santa Catalina Island

Sport fishing in the Santa Catalina Island Channel was eulogized many years ago by Dr. Charles Frederic Holder. From small beginnings the sport has developed until Avalon is now a world famous Mecca for the angler. One man has made at least two trips from South Africa, and

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winners of trophies hail from England, Canada and many parts of the United States. Famous sportsmen of the eastern states make annual pilgrimages. There is a reason why, for one may hook six different kinds of large, hard-fighting, sea-going fish, or spend a whole morning battling with a "big one."

Continued interest through the years has built up a noted Tuna Club which offers rewards for the largest fish taken on light tackle. A twenty-eight-year record kept by the club furnishes the weights of the largest fish of various kinds that have been taken. It seems hard to realize that even the ocean can produce such immense fish.

Tuna, 198½ lbs., H. S. Dudley, Los Angeles, Season 1921.
Tuna, 145½ lbs. (with light tackle), J. W. Jump, Los Angeles, 1919.
Marlin Swordfish, 354 lbs., R. C. Grey, Altadena, 1916.
Marlin Swordfish, 393½ lbs. (with light tackle), J. W. Jump, Los Angeles, 1927.
Broadbill Swordfish, 573 lbs., Geo. C. Thomas, Jr., Beverly Hills, 1927.
Giant Bass, 493 lbs., N. A. Howard, Pasadena, 1916.
Yellowtail, 60½ lbs., W. W. Simpson, England, 1908.
White Sea Bass, 60 lbs., C. B. Harding, Philadelphia, 1904.
Albacore, 65¼ lbs., L. W. McIntyre, Catlin, Ill., winter 1908-09.

Originally, it was the leaping tuna which attracted the angler. This, the largest of the tunas, is noted for its strength and swiftness, as well as for its habit of leaping ten or more feet in the air, making a beautiful curve on its leap. Large enough to swallow a six or eight-pound fish, this swift predator of the sea puts up a remarkable fight when hooked. The season lasts from April to November.

"Finer incantations," as Herbert Hoover would say, are now utilized. The flying fish is sought as bait. Rods and reels of certain weight and line of known breaking strength have supplanted the old hand lines, and kites are often

used to skip the bait along the surface in an enticing fashion. A boatman puts a kite in the air, plays out about 200 feet of line or more and attaches the angler's line to the kite string by a short piece of cord which will break at about 12 pounds' strain. The boatman and the angler then play out line together, the kite holding up the bait and skipping it along the surface. On hooking a fish the light line from the kite string is broken and the angler begins playing his fish. A modification of this "incantation" is to use a sled. The friction of the water on the sides of the runners of the sled keeps it abaft of the beam. The sled line is attached to the mast. By this method the flying-fish bait is likewise skipped along the surface.

To land a large tuna takes great skill on the part of the angler as well as endurance. The fish is often played for many hours, line being reeled in as the fish is brought to the boat and allowed to run out as the fish makes its runs. The great weight of the fish makes it necessary to "pump" in the line—raising the rod and winding in the line as the rod is lowered. This blue-finned tuna (bluefin) grows very large, one weighing 750 pounds having been taken in Japan. About the largest one recorded for the coast weighed 500 pounds, whereas the largest taken by light tackle weighed about half this amount. The yellow-finned tuna (yellowfin) claims title as a large game fish with splendid food qualities. This variety of tuna has never been taken in the Atlantic.

The albacore never reaches the size of its larger relatives, the leaping tuna and the blue-finned tuna, but provides splendid sport. Twenty years ago it was a common thing for an angler to bring back a boatload of albacore, merely to hang them on a rack and have his picture taken in front of his catch. Nowadays the albacore is more noted as a food fish emptied out of a can than as a game fish. Originally despised as food, it became the most highly prized

food fish of the state. We are reminded of the predatory character of this fish by the story told by David Starr Jordan who reports having taken an albacore in the Santa Barbara Channel which proved to be a treasure for it contained a large hake recently swallowed. Inside of the hake was a deep water fish (*Sudis ringens*) never seen before nor since.

Two other splendid fish are a delight to the ocean angler, the yellowtail, not so large but very gamy, and the oceanic bonito. The latter grows to eight or ten pounds in weight and is conspicuously marked with four long black wavy stripes on each side of a white belly.

Nowadays anglers like Zane Grey are not satisfied with tuna, but are plowing the sea in their launches from April to November, searching for still larger game. It has been found that the swordfishes afford wonderful sport. Their heavy forked tails moved by powerful muscles propel them with great speed. Few recognize them as relatives of that well-known and abundant food fish, the mackerel. Little is known regarding the life history and spawning habits of the swordfish. The eggs are apparently laid in the open sea and the young are seldom seen.

The broadbill swordfish ranges the whole ocean. Its sword is long and very strong and the fish has no ventral fins. Still more skill is needed to land one of these large fish, though fishermen land an occasional 700 pounder. It uses its sword to good advantage and many an angler can report only his one or two-hour tussle and the final victory of the fish.

The other swordfish is properly termed spearfish and goes under the common name of "marlin spikefish." It possesses ventral fins and has a large but rather narrower and sharper sword. Apparently no fishes that roam the sea are more difficult to manage after they are hooked than the swordfishes. Any angler who attempts the sport fur-

nished in the Catalina Island Channel must display patience. Even though he hire the best of launchmen, day after day he may return and acquire sunburn as a constant reminder of his endeavor, and yet go home without a trophy to display.

Both tuna and swordfish usually travel in schools, but they are very irregular. At times they seem to disappear entirely from their usual feeding grounds. Furthermore, it has been found that at certain times of the year they cannot be attracted to the surface. Though they may be present in deeper waters the angler, unless he fishes deeply, is unable to make a catch.

In the past the man who wished to enjoy ocean fishing tried his luck out on the rocks and then on piers, occasionally resorting to the more expensive method of going out in a boat. All of these methods have given a fair return for the effort and there were days when the mackerel were running that proved incentives for another try. More recently a system of barge-fishing has developed along the coast of Southern California which is gaining in popularity. By this method the fisherman is sure to have a desirable location and seldom is he disappointed in his catch. A large barge is anchored on a well-proved productive fishing ground and transportation provided by boats that make hourly trips. The charge is small because many can be accommodated and mackerel tackle is furnished free. With increasing popularity the equipment has been improved and now there are barges which provide every comfort from lunch room and electric lights to sleeping quarters. One is even able to spend leisure hours after work on the barge, for fair fishing is to be had at night. Lights attract schools of anchovies and sardines and these in turn attract the predatory fishes. One barge anchored off Long Beach during five years handled over one hundred thousand pay customers.

The main attraction to the barge fisherman is the mackerel, which is nearly always biting. In addition one has the chance to try for white sea bass, barracuda and occasionally bonito and yellowtail.

Grunion Fishing

A specialized type of fishing has appealed to many residents of Southern California. Many years ago it was discovered that on certain moonlight nights in the spring great numbers of small fish termed grunion or "little smelt" appeared along the beaches, and that these fish could be readily caught with the hands or impounded behind some wire netting. Many kept watch of the time of the year and made regular pilgrimages to Long Beach, Anaheim Landing, and other sandy beaches and brought home bucketfuls of small fish which proved very delicious.

Perhaps it was the combined lure of moonlight night and the novelty of picking up lively little fish from the sand that caused vast crowds of people to gather during the grunion runs. For many years there was no explanation as to why these fish were to be found on the sand and in the wash of the waves on several nights following full moon. Finally W. F. Thompson and other members of the staff of the State Fisheries Laboratory interested themselves in this fish and brought to light a remarkable story relative to its life history. Perhaps no other California species has such a remarkable spawning habit. The spawning is tide-controlled. During the months of March, April, May, and June, on or just after the highest tide of these months, the grunion spawns high up on the beaches. Coming in with the waves the female buries herself in the sand and extrudes her eggs several inches beneath the surface and far above the average tide. Areas are chosen where there is a run off of water, meaning an increased deposit of sand on top of the

eggs. Here the eggs remain until the succeeding high tide which usually takes place about two weeks later. The incoming tide in this same situation digs out the sand, and as soon as the eggs are freed in the water they hatch and the young fish swim back into the sea. Experiment has shown that should the succeeding tide be of insufficient height to reach the eggs, the tide a full month after the deposit of the eggs may still wash them out and free the young fish. The larvæ cannot liberate themselves from the sand but must await the action of the waves for their deliverance.

Here, then, is a fish that allows the warmth of sand which is above the level of tides to incubate the eggs. One is reminded of a turtle in this peculiar habit of burying the eggs in warm sand. Certainly, the adaptation to the tides and the spawning out on the beaches, oftentimes on the sand where there is not sufficient water to swim, is most remarkable. Further studies of the grunion by Francis N. Clark have shown that it matures at the end of the first year and that it spawns periodically every fifteen days during the late spring. Only a few of these small fish live to be three years old. Much of the information as to age and rate of growth of the grunion was obtained by a study of the rings of growth on the scales.

In recent years scientists have found the eggs of the grunion increasingly difficult to secure. The crowds of people gathering on beaches when the fish appear have continually increased. As a consequence efforts have been made to give this fish some protection. Certainly one of the fundamentals of conservation is that various forms be given total protection during the breeding season. It is now known that grunion fishing means the destruction of these fish on their spawning grounds. These same beaches that once supported enormous numbers of clams have been denuded of shell fish and it now appears that

another natural resource will need protection to prevent its extermination.

At least from the standpoint of a zoological oddity this fish with tide-controlled spawning habits, a marine fish that deposits its eggs on land rather than in the sea, is worthy of being conserved. Southern California alone possesses this resource and is responsible for its conservation.

Angling in California

Many a reader will bemoan the fact that more has been said about the various kinds of fish which attract the angler and less about the manner in which they can be taken. Angling has often been called an art and certainly descriptive words are likely to help but little in the capture of fish. What is needed is experience. Even the dry fly fisherman has to admit that his lures do not necessarily catch more fish than the more simple ones used by the farmer's boy with a willow rod, cheap line and hook. The real thrill is not to be found in the tackle, but in the knowledge and skill of the angler. Poor tackle in the hands of the man who knows where fish are found and how they may be enticed to the surface to take a fly, gets more fish than costly equipment in the hands of the man with little knowledge. It is always a pleasure to meet the man who searches less for a well-filled creel but who enjoys enticing a particularly wise and wily "big one." Seek information from the man who picks his particular trout and casts for him and through persistence gets his prize. The amateur is likely to stop his fly on the water with the result that the fish takes a look at it, discovers its falsity and swims deeper. The expert moves his fly across the surface like an insect attempting to escape from the water and the same fish rushes to the surface and grabs the fly. The amateur spends hours working a rushing cur-

rent without result. The expert drops his fly on an eddy and gets his fish.

Fish, though feeding chiefly on other fish, include in their dietary practically the whole aquatic fauna from crustaceans and insects to vertebrates. The resourceful angler notes the kind of food being taken and, choosing accordingly, gets results.

In the southern Sierra (Kings and Kern rivers regions) there is excellent fly fishing. One may easily pick a particularly large trout and cast for him. Stop your fly and your fish will often turn and start for the bottom seemingly uninterested, apparently convinced that it does not look right. Start the fly moving and the fish reappears and strikes. In the Kern River is found a distinctive large rainbow known as the Kern River rainbow. Especially large ones are sometimes taken with special lures, as, for instance, a chipmunk or piece of bacon rind.

California is more bountifully supplied with both native and introduced trout than almost any other state in the Union. The introduced species have apparently chosen distinctive niches and have not seriously competed with native species. The eastern brook trout, for instance, appears to love the slow-moving water in deep pools in high meadows. The native rainbow, however, chooses a rushing stream in a granite-walled cañon. Fish down the Tuolumne River and you will find the eastern brook plentiful in Tuolumne meadows, but much less common in the Tuolumne Cañon and Muir Gorge where the rainbow predominates. Perhaps it is the well-aerated water furnished where a stream drops rapidly that attracts the rainbow. Such knowledge is profitable.

At least five different species of trout are commonly taken in the Merced River on the floor of Yosemite Valley. They are the native rainbow, the steelhead, the eastern brook, the Loch Leven, and the brown trout. Each

has habits which, if known, bring fish to the angler's creel. The steelhead trout, planted in the Merced, are unable to reach the sea because of high dams, and although usually recognized by their more silvery color, are little different from the rainbow and occupy the same waters.

The two largest fish taken in the Merced have been (1) a Loch Leven trout taken in Steamboat Bay near Cascade Creek, in 1924, by Mr. U. N. Gilbo, which weighed 9 pounds, 15 ounces, and the other (2) a brown trout taken by Mr. Albert Skelton, near Pohono Bridge, which weighed 9 pounds, 3 ounces.

From many of the bridges across the Merced or from its banks, one may view large fish lying flat on the bottom on sandy stretches. These fish do not take a fly but are occasionally caught on salmon eggs. When lifted from the water they appear to be olive-green in color with a red stripe along the side during the breeding season. This western or Sacramento sucker is a very common native species in the Merced and other rivers. Though undoubtedly used for food by the Indians, it is despised by the white man. The only other fish found in the upper reaches of the Merced is the Sacramento pike, occasionally taken on a fly by a trout fisherman.

Lake fishing is attractive because of the large size of the fish rather than the skill required. Compared with stream fishing, resort must too often be made to spinners to attract the expert flycaster. The big ones lie in deep water and to reach them one needs a boat or a raft, especially if evening fishing is not possible. About sunset the lake fish move into shallow water to feed and they may be caught from shore. Lake fishing is always erratic. The same lures, applied on a day following a successful catch, may fail to get fish.

There are signs that fish are reacting to the numerous lures dangled before them by thousands of anglers. Fish

are becoming educated. With the years greater skill will be needed to capture them. Oftentimes fish are more shy than scarce. Yosemite Valley is typical. To the amateur there are no fish to catch. To the experienced the supply is ample. This greater difficulty of catching is not lamentable. On the contrary, it is stimulating. Such conditions are conducive to emphasis not upon the number of fish caught but on the fun of testing one's skill, and the satisfaction of a win or a loss. It is now a matter of choosing the feeding time of the fish and choosing the fly that looks good to a hungry trout. The angler nowadays must be a skilled workman with the best of knowledge and best of material equipment.

Fish Propagation

The Chinese were probably the first to demonstrate the possibilities of fish culture. California was a pioneer state in undertaking the work in America. As early as 1870, a group of men formed the California Acclimatization Society and after building a small hatchery near the City Hall in San Francisco undertook a number of experiments. Later a hatchery was built by the same organization on the University grounds at Berkeley, and this was taken over by the state in 1873, becoming the first state hatchery. In 1872 the United States Bureau of Fisheries established a salmon hatchery on the McCloud River at Baird and thereafter aided in fish cultural operations. The largest, and through the years the most important hatchery, was established at Sisson (now Mt. Shasta), Siskiyou County, in 1888. At present it is one of the largest trout hatcheries in the world, with five hatching houses, fifty-four brood ponds, nursery ponds, and several auxiliary spawning stations. By 1927 the twenty hatcheries of the state were producing thirty-five million trout and salmon per year. Long shipments are now avoided by following

a policy of establishing a local hatchery to care for the needs of each district.

Through the years trout have been distributed in the most out-of-the-way places. As a consequence, most of the barren lakes and streams of the state have been planted.

No trout were found by pioneers in Mono and Inyo counties on the eastern side of the Sierra Nevada. However during the mining days a group of miners brought a few rainbow trout in oil cans from the head waters of the San Joaquin River and planted them in Lake Mary in the Mammoth Lakes region. The fish thrived and soon spread downward into the Owens River from which many tributary streams were stocked.

The high waterfalls of the Yosemite region acted as barriers to trout. Some of the sheep herders undoubtedly removed trout from some streams to other waters accessible to their summer camp grounds. Tenaya Lake is said to have been planted by John L. Murphy, in 1878. But, according to Colonel H. C. Benson, who was responsible for most of the early distribution of fish in the park previous to 1890, there was not a fish in any of the waters of the park outside of Yosemite Valley and Hetch Hetchy, with the exception of Lake Eleanor, where a Mr. Kibbe had planted some fish in 1877.

The Wawona Hatchery was built by the California Fish and Game Commission in 1892 and began distributing fish in and about Wawona. The first fish that were sent in from the outside were some eastern brook trout that Captain A. E. Wood succeeded in obtaining from Colorado, which were planted in Alder Creek. From this source supply, eastern brook trout were widely distributed in the vicinity for the next few years.

The first actual plant made by the California Fish and Game Commission took place in the fall of 1892 when Mr. W. H. Shebley, at present Superintendent of Fish

Culture, started from the old Sisson Hatchery with a shipment of black-spotted, eastern brook, and rainbow trout. Earlier attempts had met with failure because of the long trip and time necessary. On this first successful planting the shipment arrived at Raymond whence it was sent in stages furnished by the Washburn Brothers of Wawona. At Wawona the fish were held over night in the stream and the following morning were transported by means of government ambulances to Mono Meadows. Pack trains delivered some of the fish to Ostrander and Merced lakes, to Bridal Veil Creek and to several other lakes and streams. Colonel H. C. Benson, during his service in the park, took a great interest in the distribution of fish. Special cans were made for use on aparejos, which were used exclusively by army packers, beginning in July, 1896. It took considerable experimentation to find the method best adapted to transporting fish by pack trains. The stock has been maintained by continuous heavy planting and the park now has a state fish hatchery with a splendid record. Thus it can be seen that the upper reaches of the streams of the central Sierra, now so well stocked with fish, owe their present condition to the success of fish propagation work.

Another example of sport artificially produced is that of Big Bear Lake, the most notable fishing ground in Southern California. The lake was stocked with hatchery-reared rainbow trout in 1891. The fish were carried to the lake on mule back over the old trail up the Santa Ana River. Beginning soon thereafter, and with continued planting, this lake has furnished excellent sport, though of late there has been very concentrated fishing. Big Bear Lake rainbows are uniformly large, gamy and desirable in every way. Fish are abundant enough to supply eggs for two state hatcheries situated on the shores of the lake.

For many years the planting of small-sized fish (fry)

was practiced, but in recent years the fish are held and fed for about a year, being planted as fingerlings. Resort to holding ponds has not always been found practicable as expert care must be furnished small fish.

In distribution the following policy has been followed:

Golden trout—Southern Sierra only.

Rainbow and steelhead trout—cold mountain lakes and streams.

Eastern brook—high mountain meadow streams and lakes.

Cut-throat—lower reaches of north coast streams.

Loch Leven—mountain lakes and lower reaches of streams.

Brown—lower reaches of Sierran streams.

Experience has shown that each trout thrives under certain conditions. Time would be wasted in planting eastern brook trout in north coast streams and likewise a trout such as the brown trout should not be made to compete with rainbow in a rushing mountain stream.

California, which was an angler's paradise twenty-five or thirty years ago, has now its problems of conservation. The automobile and good roads have enormously increased the number of anglers and have concentrated them along easily reached streams. Pollution is a serious menace. However, even with such adverse factors there is many a stream off main highways that brings back a picture of former conditions. Perhaps the saving grace of the situation is to be found in the fact that the angler more and more is unwilling to move far from his auto, with the result that good streams which are reached with difficulty retain their pristine glory.

Certain changes due to man threaten the sport of angling. The fish hog has been largely legislated out of business but the changing of stream channels, diversion of

large amounts of water, and the building of dams destroy breeding grounds of most fresh-water species. Ladders to take fish beyond obstructions, and screens to keep them out of irrigation ditches will not save the situation. Safety of spawning grounds is still more necessary.

Through the years, pollution has been a chief destroyer of sport. At first it was redwood sawdust from the lumber mills that killed fish; then it was debris from hydraulic mining; now it is sewage disposal and oil. Oil pollution threatens marine fish and bird life as well. Due to increasing interest the situation has been greatly improved, but oil pollution is still levying too great a toll on food and game fishes.

Reduction in the bag limit, the relative merit of a four or six-inch size limit, and the prohibition of the use of salmon eggs in catching trout, form the basis of lively discussion and claim wide interest, but these are not the fundamental factors dealing with living conditions on which interest should center. The same interest and energy expended upon the requisites of fish life are more productive of worth-while results than if spent on protection of an individual fish. Attention focused on an adequate food supply and safe and abundant spawning areas will assure future needs. The introduction of plants like *Nitella* which assure the presence of certain crustacea (such as "scuds") upon which trout feed, and the setting aside of fish reserves (like the one on Klamath River) are typical of the more fundamental conservation work we may expect in the future. Through artificial propagation, it has been possible continuously to restock depleted streams. Fish ladders, required by law, help fish to surmount dams and natural obstructions and reach their spawning grounds. Fish screens, also required by law, prevent loss of fish in irrigation and power ditches. Protective laws limit the toll taken. Numerous state hatcheries plant

millions of fish in streams and lakes to take the place of the millions that are caught. There is no need for pessimism as to the future of angling in California. The oncoming generation may pick its finny favorites and proceed to the "incantations necessary to capture them."

Chapter VIII

CHAPTER VIII

Marks for the Gunner

Men who love sport will reap therefrom no small advantage, for they will gain bodily health, better sight, better hearing and a later old age.
—Xenophon.

FROM ALL points of view the deer is the most valuable game animal in California. Since the beginning of history members of the deer family have furnished men with both sustenance and the pleasure of the hunt. Venison was the most available meat found in California in the days of '49. Nowadays, about 75,000 men hunt deer in California each year. Of the four large game animals found in the state—elk, antelope, mountain sheep, and deer—only one, the deer, is still found in sufficient numbers to allow it to be hunted.

Judging from fossil remains, deer have through time been abundant in California, and furthermore they have apparently increased in size, for such specimens are much smaller than living species. Areas on the Mojave Desert have furnished examples of one interesting extinct deer.

The average person is much more interested in answers to questions relative to antlers, horned does and distinctive habits than in the varieties found in the state. There is here expressed a hope that the reader will find among

the next few paragraphs answers to some of the questions that he has argued at various times in his life.

Yes, the antlers of a deer actually fall off each year and then grow again. It is surprising how many people are skeptical about this. Please note that the term "antlers," is used rather than "horns." To a scientist a horn is a permanent structure which is hollow, whereas an antler is a deciduous, bony structure. Starting only with a spike in the yearling, a prong is added at intervals, not necessarily one each year, until the animal is fully grown. Antlers begin to grow early in the spring and by the first of August the velvet (a skin that carries the blood supply) with which they are covered, dries up and begins to be rubbed off by the owner. The reason dropped antlers are not more often found is because the animals drop them back in thick brush where few people go. Furthermore these antlers do not last long after being dropped, for many rodents seem to enjoy gnawing them to pieces. Certainly many dropped antlers show the gnawing of these animals.

The number of points is not a sure index of age. Mule deer often develop a prong the first year. A black-tailed deer of known history showed four points at nine years of age. It has been found that the size of antlers varies greatly within the same species and that injury to an animal often causes malformations. This injury may be either to the growing antler itself, or to the sex organs.

Antlers are usually possessed only by the male deer. Occasionally a doe is found with small antlers and it is not always that such an animal can be termed an hermaphrodite. Why this well-known sexual character of antlers should occasionally appear in the female sex has not been adequately explained. Just as inexplainable is the case of a noted deer in Yosemite that carried a supernumerary antler on its nose. As a consequence, this animal

was termed a "rhinoceros deer." It developed a spike in 1926, which along with the antlers fell off in the spring of 1927. By July, a new stubby antler had developed into two points, the whole about three inches long. This abnormal growth was covered with "velvet."

Antlers are chiefly useful in defense and yet a big deer with a fine pair of antlers often drives away others not by using his antlers but by striking with his front feet. Dogs have been known to be injured in this way and as deer become tame in various parks people are sometimes injured. Bucks in fighting occasionally lock their antlers and die a lingering death of starvation.

In tracking deer the footprints of bucks may usually be distinguished from tracks of does because of the blunted points of the hoof. The doe has a sharp pointed hoof, but the buck seems to drag his sufficiently to wear it off. Endowed with good hearing and eyesight, a deer is difficult to stalk. With the black-tailed deer, dogs are often used to drive the quarry out into the open.

The color of a deer varies with the season, a bluish or grayish coat marks the winter pelage and a brownish or tan one, the summer pelage. The fawns born in summer are beautifully spotted; the spots, however, disappear with the first molt. Long legs and thin bodies give them an awkward look, but the large eyes and forward pointing ears keep them from being called ugly. For several days the fawns remain very quiet, and when disturbed, instead of running they are more likely to drop to the ground and "play possum." This ruse oftentimes is as efficacious in concealing the animal, as is the habit of quail in running and then remaining quiet. Not only does the concealing coloration and the habit of "playing possum" protect them from their enemies, but the scent glands are not developed and it is apparently difficult for predatory animals to pick up the scent of a fawn. A mother deer

leaves the fawn only when necessary to obtain food and water, never going far and always standing guard, alert to every motion or sound.

To the fawning grounds come fishermen and mountain hikers, recreation bent. By chance they discover a fawn. Truly, it does seem lost and abandoned by its mother! It is thin and starved-looking! It instinctively "plays possum" when touched, strengthening the theory that it is weakened by starvation! "Poor thing! Let's take it to camp and rear it on a bottle," is the usual comment. So the little creature is carried away while the helpless mother looks on from some concealed vantage point. Then come days of exacting care usually followed by the death and burial of the fawn.

To see a new-born fawn is a rare privilege and one's appreciation is much more intelligently expressed by leaving it undisturbed. To carry it back to camp instead of leaving it to the care of its natural mother is to commit an act in violation of the law. Though summer vacationists may think they are performing an act of benevolence, they are in reality but kidnappers.

There has been much discussion as to the food of deer. An examination of the teeth indicates that the deer is a browsing animal rather than a grazing animal. There is no question but that a deer spends most of its time eating leaves and twigs and herbaceous plants rather than grass. The leaves and twigs may be from rather strong tasting plants. Though one form of wild lilac (*Ceanothus*) appears to be a favorite of mule deer, yet willow, manzanita and many other shrubs are eaten. Deer do occasionally turn their attention to meadow grasses, though more often when feeding in a meadow they are searching out herbaceous plants.

Deer are not averse to the leaves and twigs of young apple trees and they occasionally cause considerable

trouble to the mountain rancher. Fences of sufficient height are expensive and it is fortunate that the discovery has been made that a natural aversion to blood offers an easy relief measure. The use of a spray made of blood meal has proved a repellent and has served many orchardists.

Fortunately, problems connected with the relation of game to civilization are insignificant here in America as compared with those in Africa. Herbert Lang has pointed out that in Africa:

"The gigantic size of some of the animals and the uncertainty of their temper is one of the biggest obstacles the movement for African game preservation has to deal with. Besides devastating crops, elephants by merely walking over wooden bridges may cripple traffic, and giraffes may interrupt communication by breaking telegraph wires. Zebras stampede through the strongest fencing and endanger both crops and domestic stock. Rhinoceroses and buffaloes may become dangerous by their numbers."

Most of our deer of mountainous districts perform an altitudinal migration. During the summer months they are usually found at high elevations in the mountains, whereas during winter seasons they are sometimes driven down into the valleys. Even longer migrations are apparently taken. For instance, it is a well-known fact that some of the deer from the Mount Whitney region cross the Owens Valley and winter in the desert ranges. As a rule the range of an individual probably covers less than twenty-five miles.

Both scientists and sportsmen recognize three types of deer within the state. One, the white-tailed deer, is only a casual visitor to the extreme northeastern border. The black-tailed deer is distributed throughout the Coast Range from San Luis Obispo County northward and is also found along the western flank of the Cascade and Sierra ranges to a point south of Lassen Peak. The mule

deer, the largest of the three, attains remarkable size in the extreme northern part of its range, and is found throughout the mountains in Southern California. The closely similar burro deer is found along the Colorado River. The black-tailed deer can be distinguished from the mule deer by the well-haired tail, short metatarsal gland (on outside of hind leg) which is two or three inches long, and often by the smaller antlers which seldom branch equally, each prong being somewhat smaller than the main shaft. The mule deer, on the other hand, has a strip of naked skin on the under side of the tail (a mule-like tail), the metatarsal gland is five to six inches long, the ears are very large, and there is a tendency for each fork of the large antlers to branch again. Each of these two main kinds of deer is divided into two geographical races which are similar, except for size and coloration.

The Columbian black-tailed deer is a smaller, sleeker and more graceful animal than the mule deer. T. S. Van Dyke has suggested that it bears much the same relation to the larger animal that a thoroughbred Jersey bears to a Durham. This difference in general appearance is of course most noticeable when a close view is possible. In the open, these two species look and act much the same to an inexperienced observer.

The average black-tail seldom weighs more than 125 pounds dressed; sometimes, a forked-horn weighs around fifty pounds. The length of a buck is not usually more than five feet with a girth of about three feet at the shoulders. The mature black-tailed deer usually has fewer points than the mule deer. Frequently, indeed, large deer carry forked horns only.

The black-tailed deer is largely an animal of thick brush or thick forest. Seldom is this species to be seen moving about in the heat of the day. It feeds almost entirely at night and seems to prefer moonlight nights. One may

traverse considerable sections of the Coast Range without seeing a single deer and yet "signs" may be sufficient to show that deer are numerous in the vicinity. A black-tailed deer oftentimes gives up its feeding very early in the morning, even before sunrise, and lies down in the thick brush.

The brush belt furnishes plenty of tender leaves and twigs, and this forms the main food supply. As with other deer, grass is less often touched. Leaves and twigs of salal, huckleberry, wild lilac and other shrubs are taken. In some places acorns form an attraction.

This deer has a keen sense of smell and many a hunter is amazed at the ability displayed in detecting his presence. As with other deer, this species will stand considerable noise, but quickly detects motion or human odor. The black-tail makes good use of its favorite hiding places in the brush, for it hides and sulks, oftentimes allowing one to pass at close range without attempting to run. Undoubtedly it feels more safe in thick brush even at close range than in open country.

Hunters often speak of "Pacific buck," "Pacific forked horn," "chemisal deer" or "brush buck," but these forms are apparently mythical. In spite of the many stories to be heard regarding these animals, specimens have not reached museums and students are not willing to believe that there is more than one kind of deer in the Coast Range.

Mendocino County has long been the center of abundance. In the 1927 open season 1,475 bucks fell to the hunter's gun in this county.

Reports on the annual deer kill include data as to the number of points on the antlers. As might be expected, coast counties show a preponderance of two-point bucks. In 1927 there were 853 two-point black-tailed bucks taken in Mendocino County as against 426 three-point bucks,

nearly a two to one ratio. On the other hand, Modoc County held the record for large antlered mule deer, for 262 four-pointers were taken and ten had seven points on each antler. Well-populated Los Angeles County reported 425 deer killed during the 1927 season. The total for the state was 19,507.

The mule deer always has had the highest esteem of the hunter, probably because of its larger size. Some taken in the northeastern part of the state dress as high as 200 pounds. The weights of animals taken in Modoc County probably have sometimes been overestimated, but there is dependable data to show that mule deer of this region frequently do attain large size. A buck taken in the lava beds by L. G. Renshaw in 1924, after hide, head, feet and entrails were removed, weighed 270 pounds, this being verified by Wm. S. Brown of the Forest Service. Two taken in the Granite Mountains of Nevada about September 1, 1908, were weighed carefully by F. P. Cady with a pair of steelyards, after entrails and feet had been removed. One weighed 217 pounds and the other 220 pounds. A Modoc County five-point dressed buck, said offhand to weigh 225 pounds, when actually weighed by Jay Bruce, state lion hunter, tipped the scales at 190 pounds. Mr. Bruce has found the larger mule deer bucks in the central Sierra region to weigh about 165 pounds dressed. One taken in the San Jacinto Mountains of Southern California weighed 160 pounds.

The large size attained by mule deer of the lava beds of Modoc County has stimulated concentrated hunting. A few years ago a forest officer checked 500 cars on the opening day of the season. Additional protection now has been provided by a reduced bag limit and exemption of prong bucks, which are usually but one year old, as objects of sport.

In refuges mule deer become quite tame. Visit Yosemite

or Sequoia National Park and they may be seen feeding in every meadow and often will take food from the hand. There is even danger of injury to plant life as a result of over-population, exemplified in the Kaibab deer of Arizona and those of Yosemite Valley. Wild flowers are threatened in the latter place because of a concentrated over-population of deer.

The deer population of any particular area in California is usually underestimated judging by figures obtained in an interesting way. The United States Forest Service has made computations as to the actual number in various national forests. The California Fish and Game Commission for a number of years computed the toll taken by hunters, but found it difficult to make accurate estimates of the proportion of the deer population actually killed.

Evidence that cast doubt on computation came in two strange ways: After water was turned in a ten-mile power ditch constructed on the South Fork of the American River, a large number of deer were drowned during the migration season early in spring. Immediate measures for decreasing the loss were taken. First, attempts were made to build ladders on which the deer could climb out of the ditch. Then bridges were built, but the deer seemed afraid of these and finally a deer-proof fence was erected. The actual number of deer rescued from the ditch plus the actual number of deer crossing the bridges gave a total in excess of the whole number estimated for the El Dorado National Forest, and this was simply an estimate of deer that crossed ten miles of ditch on the South Fork of the American River.

During the hoof and mouth epidemic of 1925, in attempting to suppress the disease among deer, more than 20,000 mule deer were killed by government hunters on a portion of the Stanislaus National Forest. Even then

total extermination did not take place, for deer are reappearing in fair numbers in this area.

Many hunting accidents are due to careless deer hunters. In 1915 ten persons were killed by hunters who failed to be sure of their mark. "Mistaken for a deer" makes a poor excuse for such an accident. Any hunter responsible is not only a criminal but a violator of the state game laws, for no one is allowed to shoot at a deer unless it carries branched antlers. Each hunter must know what he is shooting at. The law giving protection to spiked bucks as well as does and fawns has resulted in a lowered human toll.

Before hunting for the market was prohibited, a single hunter in Trinity County killed 2,000 deer in one season, taking only the hides and leaving the carcasses for the animals of prey. In 1880 the hides of 38,000 deer, killed in Shasta, Trinity and Siskiyou counties, were forwarded by two shipping firms of Redding, Shasta County, California. Conditions have improved, but at the present time the annual deer kill of the state is remarkable.

Deer, like most animals, have power of rapid recuperation, provided a breeding stock is maintained. Though about 20,000 are killed annually by hunters, those who are conversant with the situation are ready to say there are many more deer in California at the present time than were found here during the late seventies and early eighties when hide hunters took a large toll. Deer are found in practically every county with the possible exception of two: San Francisco and Sacramento. At least 2,000 deer are killed annually within a hundred miles of San Francisco. The great expanse of rough brush-covered areas makes California a splendid home for this fine game animal.

The abundance of deer in the state is due also to long years of wisely planned protection. The first law giving

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protection to deer, one which first provided for a closed season during the spring, was passed in 1852. The more recent steps in deer conservation have been:

1. Protection for does.
2. Small bag limits.
3. Control of mountain lions.
4. Protection of spiked bucks.
5. Protection of pronged bucks of the Modoc mule deer.

Because deer mature earlier in the Coast Range than in the Sierra the open season is set at different times, opening a month earlier along the coast. A month and a half gives ample time in each instance and the time set allows the taking of deer when they are in their prime.

The greatest enemy of the deer is the mountain lion, sometimes called panther, cougar and puma. As a deer conservation measure bounty is paid on this animal and lion hunters are employed. Stories indicating that the mountain lion endangers human life, and those about the weird call of the animal, are exaggerated and not well supported. Circumstantial evidence is usually responsible. Mr. Bruce, state lion hunter, who has killed more than three hundred lions, supports this view.

A study of the food habits of the wildcat indicate that rodents rather than game constitute the major part of the diet. The coyote is destructive to game in some places, particularly in winter.

Most of the other predatory species are classified as fur-bearing animals. Of these, California has but part of her original endowment. The fur trade flourished in this state the first twenty years of the nineteenth century. Seventeen American ships plied up and down the coast trading in sea otter skins. The sea otter is now practically extinct along the coast and the wolverine, fisher and

marten are becoming very scarce. Fur farming is a new industry in the state and may help to save a supply by means of domestication.

I do not side with those who blacklist predatory species and demand constant warfare against them. Rather do I side with John C. Van Dyke in the thought: "We like or dislike certain things which may be a way of expressing our prejudice or our limitation; but the work is always perfect of its kind irrespective of human appreciation." Predatory animals play an important part in the economy of nature and their classification as "vermin," with consequent elimination from the fauna, constitutes a grave danger.

Elk

Wapiti, usually called elk, of two kinds, were once common game animals. A larger form was found along the coast from San Francisco Bay northward; a smaller species roamed the San Joaquin Valley and surrounding foothills. Early explorers found them also in eastern Monterey County. The coastal form is now limited to less than a hundred individuals found in Humboldt and Del Norte counties and the other, the valley elk, to about four hundred wild animals in Kern County. Elk have received total protection for many years. Reduction of numbers began in the Spanish days when the animals were needed for meat and tallow. The great herds of Marin County and the San Joaquin became but a memory in the early fifties.

Joseph Warren Revere, a direct descendant of Paul Revere of Revolutionary times, took an active part in the conquest of California and raised the American flag at Sonoma. In a book entitled *A Tour of Duty in California*, he describes an elk hunt near Point Reyes in Marin County in August, 1846. The herd attacked by a party of Span-

iards numbered "not less than four hundred head of superb fat animals." Some of the animals were roped and then hamstrung; others were shot. Here is a glimpse of the abundance of elk in the immediate San Francisco Bay region, when herds first began to be decimated.

Definite attempts to save this largest game animal of the state by transplantation have been made. In 1905, a few were transferred from Kern County to Sequoia National Park. In 1914 and 1915, the California Academy of Sciences captured and shipped a total of 146 elk to some nineteen different reservations and parks, the start of several small herds which have furnished enjoyment to thousands. The animals placed on the Pacific Improvement Company's property near Monterey became so troublesome to residents that they were subsequently moved. A dozen elk were at a later date placed in a paddock in Yosemite Valley. The herd has steadily increased in numbers and in the summer of 1927 the animals were temporarily given their freedom. In spite of depredations on farm crops the Miller and Lux Company, on whose ranches the elk live, have given the animals protection in their San Joaquin Valley holdings.

Though given a closed season, the present status of elk in California demands additional provision for the remaining wild animals. An elk refuge in the lower San Joaquin Valley is badly needed. The lodge which takes its name from this animal might well assess its members to care for the Kern County herd.

Prong-horned Antelope

The prong-horned antelope was originally such an abundant animal in California that antelope meat was procured in the city of San Francisco for a lesser price than was paid for beef. Antelope ranged over the entire plains area of the state, including the desert. This species ap-

pears to be losing ground here as elsewhere in North America.

In many ways the prong-horned antelope is remarkable: structurally, in various habits, and as the only antelope of the New World. The horns, possessed by both sexes, unlike other antelopes, are branched and are shed and renewed annually. E. W. Nelson describes the loss of the horn as follows:

"When the time for shedding arrives, the horny sheath gradually loosens and becomes detached from the skin around the base and, following this, from the bony core within. Later the horn falls off, leaving the bony core covered with blackish skin more or less overgrown with long, coarse hairs, which afterward are gradually lost. A new horny nucleus develops on the tip of the bony core, the horny growth then extending slowly downward until it reaches the base, gradually thickening and hardening, the horny material grows at the tip until the new horn attains its full development. The horns continue to grow as the animal increases in age until the full size is reached."

The pronghorn has a peculiar method of signaling when disturbed, the hairs upon the rump being erected to make a white flash that can be noted at a greater distance than the well-camouflaged animals themselves.

Curiosity is another characteristic. Early hunters soon learned of this and used it to advantage in luring the animals within gunshot. A coat placed on a gun and waved back and forth, or heels kicked in the air from a reclining position were often used to decoy antelope, whose overwhelming curiosity would bring them quite close.

In a narrative of the Portolá expedition of 1769-1770, Miguel Costanzó thus described how the primitive California Indians succeeded in approaching antelope:

"They are also great hunters. In killing deer and ante-

lopes, they employ an admirable device. They preserve the skin of the head and of part of the back of one of these animals, removing it with care, with the horns left attached to the skin and filling it with grass or straw to keep its form. This mask they put like a cap on the head, and with this odd equipment they set out for the wood. On seeing a deer or antelope they crawl slowly with the left hand on the ground, carrying the bow and some arrows in the right. They lower and raise the head, turning it from one side to the other, and make other motions so characteristic of these animals, that they attract them without difficulty to the decoy, and having them at short range, they discharge their arrows with sure effect."

Still another peculiar habit noted by early hunters was that of racing. When a horseman approached a band the animals lined out and raced off in a parallel direction, finally cutting across in front of the rider. Even single animals seemed inclined to start a race with any approaching horseman.

Of the former enormous numbers of antelope, there remain only two large and several smaller bands. The largest, perhaps numbering less than a thousand head, ranges back and forth across the California-Nevada line in Lassen County. Another band ranges the Mt. Dome region of Modoc County. Both these herds are given special protection by means of an antelope refuge. Smaller herds, at least up to 1922, were to be found in western Merced County, northern Los Angeles County, northwestern San Bernardino County, and southwestern Imperial and southeastern San Diego counties. It is probable that at least 500 animals are to be found on the Lower California peninsula. The antelope is an animal that does not withstand civilization. Only the most careful protection will assure its survival even as a rare animal confined to refuges.

Mountain Sheep

Mountain sheep, because of their wariness, have long been highly valued game. With the depletion of the species near home sportsmen have journeyed to Canada and Alaska and now they even go to Siberia.

The name "big-horn," often applied, has reference to the large curved horns possessed by both sexes. The animal stands about three feet high at the shoulder and weighs about 200 pounds. The horns are large in proportion, nearly three feet long measured along the outside curve and fifteen to twenty inches in circumference at the base. The color is brown with a white patch on the rump. Long crinkly hairs with underfur densely clothe the body.

Once widely distributed in California in mountainous districts, from the Oregon line to the Mexican line, only a comparatively few remain and these are given full protection by the law. The last of the mountain sheep of the Mt. Shasta region were killed by Indians and settlers in the seventies. The last of those found in the central Sierra died at the hands of the sheep-herders about the same time. A small number range the summit region near Mount Whitney, a band still persists in the inaccessible parts of the Sierra Madre range, a band finds a home in the Santa Rosa Mountains, and numerous bands are found on the desert ranges. The mountain sheep is a hardy animal and the desert species is likely to persist, for here there is little encroachment on the barren territory which furnishes them sustenance. However, it is doubtful whether conditions will be sufficiently favorable to allow of an open season.

Small Game

Rabbits and squirrels have always been considered the game of the small boy. Certainly in a state where rabbit drives had to be instituted to diminish the numbers and

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allow the growing of crops, this kind of game should be found in abundance. The pioneer feasted on cottontails and young jack rabbits. The hunter who took his jack "on the run" without a miss soon held the marksmanship title of his community. Jack rabbits are still so abundant as to menace crops, and state law still brands the jack rabbit as a "predatory animal" in order to blacklist it. In many a market in the larger cities in winter one is able to purchase a jack rabbit for a small sum. Rabbit drives are still held. They constitute a modern method of slaughter though often advertised as a sporting event. The animals not used by participants are skinned and sent to market. What a gold mine a fur dealer might have found a few years ago by retrieving the hundreds of skins that formerly went to waste at these drives! Talk to the pioneer rancher and you will understand that these drives were really a necessity in past years to save small growing fruit trees and other crops. Coyotes once helped to keep the jack rabbit in check, but, falling under man's displeasure, the best known check has been removed to such an extent that man's more artificial program of destruction must be relied upon.

The cottontail is a burrowing rabbit. It may be found in open as well as brushy areas. It seems to prefer the thickets along streams. From the smaller brush rabbit it is distinguished by longer ears, about the length of the head, grayish coat and cottony white under surface of tail. The cottontail is only about one third the weight of a jack rabbit. It forages in open places and dashes to cover at the slightest disturbance. Nearly every rurally situated family appreciates the food value of this animal.

In general, the brush rabbit is about half the size and weight of the cottontail. Shorter ears, bluish gray color, much darker than that of the cottontail, and a less white tail are also characteristic. In habits it is much like the

cottontail but it stays more closely to brush areas. Foraging is done in the morning and in the evening. Ability to dodge quickly adds a safety factor to its habit of staying close to thick cover. Even some of its food is gleaned from brush twigs rather than grass and herbage. The brush rabbit is widely hunted. Being more abundant than the cottontail it probably forms the larger part of the bag of every rabbit hunter. One thing that complicates the hunting situation is the fact that because of depredations it is given no protection in Southern California, while in the north sportsmen demand a closed season. It is true that this animal, along with the cottontail and jack rabbit, barks young trees wherever they are surrounded with brushy areas, and it seems reasonable from the farmer's standpoint that it should be reduced in numbers. Though nowhere as numerous as formerly, there is no immediate danger of California's having to import and reestablish rabbits as small game for the hunter, as several eastern states have been forced to do.

The largest and most beautiful of California arboreal squirrels, the gray squirrel has been a favorite mark of the boy hunter. Should the marksmanship be good the boy is able to carry home a sizable animal, nut fed, and savory to the taste. Furthermore, the skin makes a worthwhile memento.

A serious epidemic in 1920-1921 so effectively reduced the number of gray squirrels that up to the present time the species has not been able to recuperate. The disease, the result of a skin mite, spread throughout the interior mountainous region. Dead squirrels were reported numerous. In Yosemite Valley, where gray squirrels were once very abundant, but two or three were seen in the five years following the epidemic. The Coast Range and Southern California largely escaped the malady. No

doubt the species will eventually return to normal numbers, but continued protection will be needed.

Only those in the higher mountains make use of the much smaller chickaree or "pine squirrel." The commoner ground squirrel once fell prey to every boy's gun and not infrequently arrived on the home table as food. However, the discovery that this animal may transmit the most dangerous of plagues, the bubonic plague, has taken away the incentive to hunt it. Its numbers are now reduced by poison campaigns designed to give protection to the farmer and prevent the spread of a dread disease.

Water-Fowl

The boy with his first gun, discovering a small flock of ducks on a nearby pond, crawls on his stomach to a vantage point from which he shoots at the sitting birds. Later, in a boat, he may attempt to stalk birds loafing on open water. This sort of hunting in reality takes more skill than that practiced at present where the hunter sits in a well-camouflaged blind and calls in the ducks to a baited pond, set with decoys. It is to be noted, however, that the hunter in his prepared blind shoots the birds on the wing. Instead of firing into a flock he picks his bird, leads it carefully, drops it and picks another for a "double."

Ever since a daily bag limit has been set, the wild-fowl shooter has felt obliged to attain the full quota of birds in order to brag of his prowess. In many instances he attempts to hold to his record by "piecing out the bag limit." In other words, he carries home some of the birds shot by a more skillful hunter. This should be considered unethical just as is violation of a three-days-a-week shooting rule at most clubs.

When one reads the reports of the early explorers or talks with some white-haired market hunter, one is easily convinced of the abundance of water-fowl in the early days.

A great chain of marshes extended from Buena Vista Lake, Kern County, northward nearly to Mount Shasta. Here thousands of water birds found nesting places and, during the winter, migratory birds from the north swarmed in untold numbers in these marshes. Present-day conditions are much less favorable, most of the lakes and marshes have been drained to furnish additional agricultural land.

The one large marshy tract still left to the state is that near the mouth of Butte Creek in the heart of the Sacramento Valley, an area that has been made more attractive in recent years with the growing of rice. As a consequence, it is here that ducks and geese are found in greatest abundance. Their numbers, however, may appear large because of the necessary concentration. The birds that formerly found feeding places in widely separated marshes now gather in the only one that is left to them.

The duck appearing in greatest numbers is the pintail, commonly known to the hunter as "sprig." Long pointed tail and the white stripe on the neck of the male mark this duck. Though a few nest in marshes of the great valleys, the progeny of these nesting birds in no manner accounts for the myriads which arrive in late September. A trained observer is bewildered by the numerous flocks which need to be counted in making a census. One is led to use the term millions much as the modern financier uses it. Considerable complaint has been made of the damage in the rice fields, done by pintail ducks while feeding. In a few instances the damage was real but in more instances those fields containing considerable open water were the ones chosen by the ducks for night feeding. The peculiar murmur or "gabble" uttered by pintail ducks as they feed in a rice field is one never to be forgotten.

It is in this region that the mallard duck, the one usually most highly prized by the California hunter, is found in greatest abundance. Mallards congregate along deep

sloughs and nests are placed in open fields nearby. Whether it be the gun club member, the independent shooter, or perhaps the guest on a state public shooting ground, the hunter's outstanding ambition is to secure mallards as against any other kind of duck. Mallards are resident.

The second most abundant bird from the north is the American widgeon or baldpate, a smaller duck and one which feeds more largely upon grass than do others. Green-winged teal are choice "little ducks" and test the marksmanship of the hunter because of their rapid flight. At the very opening of the season the brightly colored cinnamon teal, a summer visitant to the valleys, is occasionally taken. About small ponds the cinnamon teal is the commonest nesting duck in summer.

It is universally accepted that the wood duck is the handsomest of all the ducks of the United States. The only rival claimant to equal beauty is its relative, the mandarin duck of Asia. As far as brilliancy of coloration is concerned even this species may be given second place. The wood duck's habit of making special display of its bright colors adds to its ever evident beauty and grace when on the water.

In California the wood duck was formerly well distributed throughout the low country west of the Sierra. Now it is a rare local resident of the Sacramento and San Joaquin valleys and westward to the coast, frequenting the timber-bordered streams and fresh-water sloughs, especially in the oak belt. Although permanently resident within the state, the species appears to be slightly migratory, moving toward the north in April and to the south in October. It is rare in Southern California where as a rule favorable conditions are lacking.

So conspicuous and distinctive is this duck that field marks are hardly necessary even for the uninitiated. The crested head crossed by white stripes, the pure white under

parts and the bright metallic colors always betray the male. The female although lacking the bright coloration of the male, displays much more color than the females of other species and in addition can be recognized by a white eye ring which extends back of the eye as a white streak.

Wood ducks seldom stray away from the secluded, wooded streams and sloughs which constitute their habitat. Not only does the wood duck perch in trees but it invariably chooses a hollow in a tree for its nesting site, the nesting cavity perhaps forty or fifty feet above the ground. The nest is sometimes placed several feet below the entrance to the hollow. Twigs, grass and leaves are used as building materials and the lining is of down. A deserted woodpecker's nest enlarged through decay is ofttimes used. The hollow end of a broken-off branch is said to be frequently selected. A favorite food is the acorn, swallowed whole.

At the present time the wood duck exists wild in such small numbers that it is properly afforded complete protection by both state and Federal law. Its flesh is declared to be delicious and since it has proven itself readily domesticated there seems no good reason why it cannot be raised in captivity as a commercial proposition and sold on the market. At present there is a brisk demand from breeders and pleasure parks for this, the handsomest of the duck tribe.

On first thought no one would think of interrelations between beaver and wood ducks. Yet after protection was removed from beavers in 1925 and trappers had taken a heavy toll of these animals along the Merced River near Snelling, a splendid breeding place for wood ducks was destroyed. The beavers built dams and impounded water so as to form quiet ponds surrounded by willows. With the destruction of the beavers and damaging of dams by freshets, favorable conditions ceased to exist and a census

showed that a sizable colony of wood ducks had moved elsewhere. Man appears to learn but slowly the extent of interrelations in nature and the need for holding to natural conditions as far as is possible.

Along the shore of San Francisco Bay one sees a number of strange-looking objects anchored in the water. Close inspection shows them to be tule or brush-covered duck blinds. The hunter sets his decoys and hides his boat within the blind, then awaits the arrival of "bluebills" or the larger canvas-backs. These two diving ducks may be seen rafted in numbers on the San Francisco and San Pablo bays. They feed largely on shell fish, which makes them rather poor as food. Nevertheless these wary diving ducks entice the local hunter who owns a boat or who can rent a boat and decoys from a nearby "ark." Sometimes a hunter may drop a few birds by stationing himself well out on the shore at low tide and practicing "pass shooting." Seldom does the hunter take a limit along the bay shore, but he does have fine sport when the birds are flying.

The most despised diving duck is the ruddy which is almost impossible to pick clean of feathers and tastes at times "like a pint of crude oil." The ruddy is common on fresh-water ponds everywhere. In summer, the males are strikingly reddish colored with pure white cheek patches, and add to their attractiveness some remarkable courting antics.

Collectors of birds' eggs travel to the ends of the earth to add to museum collections a clutch of eggs never before found. Through the years California collectors have checked off one after another of the rarer birds—rosy finch, pine grosbeak, Clark nutcracker. There yet remains an interesting find for someone—the nest and eggs of the harlequin duck. Many years back a bird student discovered an empty nest which he took to be that of the

harlequin, and afterwards sent young birds to the Smithsonian Institute, thus proving that this rare duck actually nests along Sierran streams. Mr. Belding it was who found them along the Stanislaus and Tuolumne rivers. Since those early years the harlequin duck has been located a number of times along rushing mountain streams. A pair were studied and photographed in Yosemite Valley in 1922.

The male harlequin is bizarrely colored with white on a slate-blue ground. The female is browner with two white patches on each side of the head. Although spending the winter season on kelp beds off the rocky coast of California and other Pacific states, the harlequin appears to seek the rushing mountain stream for its summer home. This duck is an adept swimmer and diver, and may be seen diving to the bottom in swift currents. In the Yosemite I have seen them working on a gravel bar where the water was not more than six or eight inches in depth, but which ran swiftly. They seem to be able to hold themselves to the bottom where they seek food among the small rocks. An additional mystery regarding the bird is yet to be solved. Over what route does it pass in moving from its summer home to its winter feeding ground along the coast? As yet no one has observed the bird in the intermediate area. This water bird, which has chosen much the same niche as that occupied by the water ouzel, is a rarity to bring a thrill to the oldest and most experienced of bird observers.

Duck shooting, though it calls for discomfort, is very popular. The poorer the weather, the better the luck! Furthermore, one must arise early and wear hip boots. The thrill of seeing ducks drop to decoys and of testing marksmanship on a fast flying one is more than sufficient to draw thousands to this sport. Moreover, the thoughts of a roast duck should stir anyone to action.

Up to 1928 there had been but two duck sanctuaries set aside, both fine examples. An augmented program, financed by hunting license fees, assures additional ones. Lake Merritt, in the heart of the city of Oakland, became California's first game refuge in 1869, before there was a Fish and Game Commission and before protective laws were passed. Through the years this refuge has given a haven to thousands of wintering ducks. Maximum counts have shown nearly 4,000 birds. A fine flock of canvasbacks occupies the deeper north end. Thousands of pintail and baldpates and a few shovellers and green-winged teal loaf on the shallower part. Golden-eyes and buffleheads remain nearer the center of the lake and the ever present ruddy shows his white cheeks everywhere. The city of Oakland feeds these wintering ducks twice daily and has furnished ponds of fresh drinking water for them. The pintails and baldpates come out on the lawns at feeding time, becoming quite tame. For several winters the rare European widgeon has been noted. These flocks of ducks remind one of a game farm, but they are all, with the exception of a few domesticated mallards, migrant wild ducks. It would be hard to find a finer example of results to be expected from a properly conducted bird refuge. Richardson Bay, part of the Tamalpais Game Refuge, furnishes shelter and safety for thousands of canvasbacks and "blue-bills" during their winter sojourn.

Although no actual census of the toll taken each year has thus far been made, California sportsmen probably kill about one million ducks per year. It is known that in 1911 and 1912, when ducks were still allowed to be sold in the market, that more than three hundred thousand were sold in the markets of San Francisco alone. If we add those sold in other markets, and then add the total taken by sportsmen throughout the state, the numbers must have mounted well above a million. Poor hunt-

ing seasons were experienced in 1924, '25 and '26; there was much speculation as to the cause for the poor flight of birds. Many advocated a reduced bag limit. Probably a more potent reason for these poor seasons than over hunting is to be found in the reduced areas attractive to ducks and to the fact that hundreds of thousands died as a result of "duck sickness," sometimes termed alkali poisoning. A map of the Great Valley of California, made by the state engineer in 1882, shows a continuous chain of marshes from Kern County to Shasta County; a present-day map would indicate cultivated land where once there were marshes attractive to wild fowl. Continual reclamation projects have increased agricultural lands but greatly decreased marsh land. It cannot be expected that wild fowl will be attracted to cultivated fields; they must have suitable water areas with abundant plant life to furnish a food supply. It seems very reasonable that many of the migrant ducks from the north, not finding suitable feeding grounds, continue their journey to the unreclaimed marshes of Mexico and Central America.

Wherever large bodies of water have been drained in the West, there appears almost annually a peculiar malady among the ducks which resort to the restricted water areas. They first lose the power of flight, then their legs become paralyzed, and finally they lie dead on the shore. The first investigations indicated that concentrated salts in the water were responsible; the thing that lent credence to this theory was the fact that sick birds made a rapid recovery when given pure, fresh water. More recent investigations indicate that there may be outbreaks of this disease in places where there is not a strong concentration of salts. Eventually it may be demonstrated that duck disease is caused by poisonous gases or poisonous materials, the result of decaying vegetation. Severe epidemics have broken out on a number of different occasions on

Tule Lake in the northeast corner of the state, and at various places in the Sacramento Valley, as well as at Tulare and Buena Vista lakes at the southern end of the San Joaquin Valley. The government has estimated that in western states during the fifteen years preceding 1926 at least fifteen million ducks lost their lives as a result of this malady. Such a toll might well bring about depletion in the number of ducks visiting the state and knowledge of the exact cause is urgently needed.

Probably no state can boast of more geese than California, yet few birds are actually reared within the state. Attractive food and cover through the centuries have brought untold numbers of geese from central Canada and the Far North to winter here. Seven different species of geese are winter visitants in the state, but only one, the Canada goose, or "honker," nests within our borders, and this one is found in only a few of the higher mountain lakes.

Three kinds of geese found in California have black heads with white cheeks. They are to be distinguished in life by differences in size and call note rather than by coloration. As a rule, the largest one is termed Canada goose, the middle-sized one, Hutchins goose, and the smallest one, cackling goose. The cackling goose, because of its high-pitched peculiar call note, is termed by the hunters "yelper." The Canada goose has been found nesting at Lake Tahoe and Honey Lake, and was formerly found nesting on Lower Klamath Lake. The two smaller varieties hail from Alaska and other northern points.

When one visits the "goose grounds" in Sutter and Butte counties one finds that the white-fronted goose, the "speckle belly" of the hunter, is most in evidence. Likewise it has been a favorite. Its distinctive call is to be heard in every direction as morning and evening flights

take the birds to the stubble fields where they glean the waste grain. The middle of the day finds them loafing on open water.

Until recent years it was not generally known that two types of white-fronted geese were present in the state. About 1915 or 1916 persistent reports of a very large variety of "speckle belly," which occasionally appeared in the marshes near Marysville in Butte and Sutter counties, led scientists at the University of California to seek specimens. This larger goose was locally known as tule goose. Additional tangible differences besides size were found in color of plumage, number of tail feathers and in a conspicuous yellow eye ring. In searching for the proper scientific name it was discovered that the original description of the American white-fronted goose made in 1852 better fits the larger bird than the much commoner small one which is not appreciably different from the European variety.

The outstanding features of the rare tule goose of California may be summed up as follows:

1. The tule goose has a much darker shade of brown on the neck and head. Weights run six and seven pounds against four and five pounds for the white-fronted goose.

2. It frequents the heavily wooded banks of the larger sloughs, and the ponds in the midst of heavy tule growth. It does not seem to leave this area for stubble fields as does the white-fronted goose.

3. In flight, the larger bird has slower, more measured wing beats. It flies closer to the ground, seldom attaining an elevation of more than 200 feet.

4. Flocks of tule geese are composed of fewer individuals than those of the white-fronted geese; six to eight birds of the former as against twelve of the latter are the rule.

5. The voice of the tule goose is noticeably harsher and coarser than that of the white-fronted goose.

White geese sometimes cover the plains in such numbers that the surroundings look as white as if covered with snow. Two varieties of white geese winter in California, the larger one known as the lesser snow goose, and the smaller one as Ross snow goose or "China goose." The smaller bird when in hand may be easily recognized by the warty protuberances and rounded corrugations on the upper mandible. The mileage covered by this goose in its migration is not known, for no one has yet taken the nest or eggs of this species. The breeding grounds are supposed to lie along the Arctic coast bounded by the region of Fort Anderson on the west and Hudson Bay on the east. The bird has been observed in Victoria Land, the northernmost land area in North America. The path followed in migration appears to be different from that followed by almost any other species. The greater number seem to concentrate on Great Slave Lake and Lake Athabasca on leaving their breeding grounds. They continue south to western Montana and then turn southwest, cross the Rocky Mountains and spend the winter in the great valleys of California. The only place where the Ross goose has been found in midwinter is in the State of California. As a consequence, California is responsible for the safety of this species, and the cackling goose also, for should too great a toll be taken by the hunters these interesting varieties of geese could easily be blotted out. Only those left untouched by the hunters of California and by those along the migratory route form the nucleus of the breeding stock for the future.

There is little danger of exaggeration in stating that geese formerly came to the state by the million. For many years the birds were so abundant that complaint was made of their depredations in grain fields and they were

slaughtered in countless numbers without limit of any kind. Now some are willing to say that hardly one goose returns to the state where two hundred formerly came. The Canada goose, perhaps most highly prized because of its size, is comparatively rare. Even the gray goose or "speckle belly" shows great reduction in number.

The black sea brant is a visitant to certain coastal bays where eel grass forms an attractive food supply. This is the one goose which frequents salt water. Fortunately, this bird is wary and difficult to shoot. Otherwise it might have disappeared entirely as a result of concentrated hunting, for to many its succulent flesh is more desirable than that of any other goose. Though sometimes hunted from boats, "pass shooting" is the usual method employed.

A bird nearer goose than duck in structure and found in the southwestern United States, Mexico, southern Uruguay, Argentina, South Africa and India, is known as the fulvous tree duck. Extra long legs and long neck together with the fulvous brown color mark the bird. Its name does not fit it in California, for so far as is known it does not perch in trees when with us. It nests in fresh-water marshes in the San Joaquin Valley. The tree duck is noted for large clutches of eggs, sometimes perhaps the combined laying of more than one female. A few tree ducks are killed when the season first opens but the greater number have already moved south by that time. The best tree duck shooting is in Mexico, where this bird winters regularly.

Rails are typical marsh birds. A fine large rail, the clapper rail, once very abundant in the salt marshes of the state, was much appreciated as a game bird. As this rail takes flight from marsh vegetation, it rises six or eight feet in the air and flies directly away from the gunner, making an easy mark. Not satisfied with the real sport afforded by starting the birds while walking

through the marsh, some gunners awaited a high tide when a concentration of birds was to be found on the higher points of land on some island. This intensive slaughter, coupled with reduced breeding grounds, and the introduction of the European rat, have combined to reduce the number of clapper rails to a point where they have needed the total protection given them. The clapper rail feeds along the edges of the sloughs, eating small crabs, worms and insects. Nests, which often contain eight to nine eggs, are hidden away in pickle weed, a common plant in salt marshes.

At least four other rails are found about fresh water in California. Two of these, the Virginia rail, a small edition of the larger clapper rail, and the black-faced, short-billed sora rail, were widely hunted previous to the passage of protective laws.

Shore Birds

A thousand miles of coast line furnish feeding grounds for numerous shore birds, practically all of which once helped to fill the bag of the "pot hunter." Flying in close set flocks these birds afforded "pot shots," with dozens of killed and wounded birds to be retrieved. There was variety in size; some, like sandpipers, would hardly make a mouthful, others like long-billed curlews, willets and godwits, would make a meal. Then, too, colors were enticing, especially during the spring migration. Most of them during the spring wear black and red in their plumage. Little did the man who slaughtered these birds, before Federal laws prevented, think of the migration routes interrupted. Many of the birds to be found feeding along the coasts of California, and less often in marshes, are in the spring on their way northward to breeding grounds within the Arctic Circle. Many of those killed during the hunting season were on their way to

the coasts of central and northern South America, and some of them would have reached the coast of Chile and Patagonia.

As a consequence of total protection since 1913 there are still birds in great variety to be observed and enjoyed in life, even though law has sealed the hunter's gun and a specimen in the hand is not allowed. A winter trip along the ocean shore from Santa Barbara to Los Angeles, or, again, from Los Angeles to San Diego, will furnish the traveler with endless enjoyment if he use his eyes along the beaches. The commonest long-legged bird with a long down-curved bill is the Hudsonian curlew, still larger is the rarer long-billed curlew. Of nearly equal size but with cinnamon colored patches on the wing and with slightly up-turned bill, is the marbled godwit. A grayer bird with shorter black bill and a white patch on the wing bordered with black, is the western willet. An occasional black-bellied plover, red-backed sandpiper, or long-billed dowitcher reminds us that there are medium-sized shore birds. If the eye can pick a tiny snowy plover as it advances rapidly and stops short, to be lost in the background of sand, one has a good test of eyesight. One will inevitably see small flocks of birds, whitish in color, racing down the beach behind every receding wave and probing feverishly and then racing out before the advancing wave. Sanderlings you should name them. This little bird is found almost the world over. West coast birds winter in central Chile, whereas those of the Atlantic Coast go as far south as the central shores of Argentina, and those of the Old World to southern Africa.

Several species of shore birds, notably the long-billed curlew and knot, have been notably reduced in numbers. Both Federal and state laws now give protection to all of the shore birds in California with the exception of the

Wilson snipe or "jack snipe," the bird which forms the noted test of marksmanship because of its zigzag flight. Its flesh is of excellent quality, its small size helping to make it a special delicacy. The Wilson snipe has a bill two and one half inches long and, as the bird is watched, it seems to have difficulty in holding its head high enough to keep the bill off the ground. Color markings include a distinctly striped head and back and a mottled breast. A peculiar crouching attitude is characteristic. Long-billed dowitchers, which have bills nearly as long, lack the striping, have white rump patches, and are usually seen in flocks. The snipe frequents grassy areas; the dowitcher, mud flats and sandy beaches.

Among naturalists the snipe is known for its peculiar nuptial flight which most often takes place at night. High over head the bird dashes about and diving downward gives a rolling series of notes. The Wilson snipe has been found nesting in high mountain meadows in California. However, birds nesting within the state are not sufficiently numerous to account for the large numbers found in fresh water marshes during the winter. It is believed that most snipe are winter visitants from the North.

An alkali pond in the great valleys in summer is a noisy place. Here are to be found two members of the shore bird group which herald the intruder's approach with loud calls and much flying back and forth. Both are conspicuously colored, with long necks and long legs, and are quickly recognized as avocet and black-necked stilt. The two birds show structural relationship as well as a tendency to choose the same sort of habitat.

The avocet is the most showy among American shore birds. Its white body and black wings with white stripes render it conspicuous even though the loud call-note fails to catch the ear. The bill is long and slender

and curves upward, the legs bluish in color and the feet partially webbed. One of the interesting mannerisms of this bird is its habit of keeping its wings raised for a short time after alighting. The avocet has a peculiar stalking gait and as it wades about in the water, it swings its bill backward and forward through the water sifting out small particles of food. A lined depression on some island or on the bank of an alkali pond is used as a nest. Four large brown-spotted eggs are deposited. The young are able to move about very soon after hatching. In flight, the avocet presents a beautiful picture in red-brown, black and white, with the long legs streaming out behind.

The black-necked stilt is properly named for it has extremely long legs, and its white body is marked with a black stripe down the back of the neck. To this unusual marking are added black wings. The legs and feet are red, the bill is shorter than that of the avocet and is straight. Small insects, snails and worms make up the food, secured by wading about in shallow water and picking the food from the surface or from the mud beneath the water. In addition to making an outcry, stilts show excitement by bending the legs, drooping the wings, and quivering all over. Nesting habits are very similar to those of the avocet.

Before protection was given to the shore birds, the avocet and the stilt were considered fine game birds. However, with a late fall open season few were available, the greater number having already started toward Mexico and Central America. Though not now numbered among the birds sought out by the hunter, every sportsman can get a real thrill by investigating some alkali pond during the nesting season.

We think of most birds as migrating in a north and south direction, yet there is one shore bird which apparently travels east and west and crosses two mountain

chains in its migration. On the alkali plains of the San Joaquin Valley there formerly gathered great numbers of mountain plover to spend the winter season, a bird that nests in Colorado, Kansas and Nebraska.

The mountain plover, more than any other shore bird, with the possible exception of the killdeer, is a bird of the dry, open plain. It has sometimes been called the prairie plover. Whereas most shore birds seek the seacoast, the mountain plover appears to avoid it. Here, also, is a bird that is typically North American, being restricted to the southwestern portion of the continent.

From the standpoint of the hunter, the mountain plover is worthwhile in that it furnishes a different type of hunting; furthermore, residents of the interior may find at hand a shore bird without traveling to the seacoast. Mountain plover are finding restricted feeding grounds and what once was a common sight, thousands of plover feeding out on the open plains, is now an unusual scene. However, since this plover has a habit of appearing at irregular intervals, it may be that the bird is not as badly depleted as might be indicated by the rarity of its appearance in the San Joaquin Valley. At any rate, it is likely to be a long time before the state can safely modify the protective law which prevents it being hunted.

Many wild-fowlers laugh at the southerners who have persisted in hunting "grosbeck," a nickname for the young of the night heron, yet eastern hunters might well poke fun at California for long demanding an open season on the white-faced glossy ibis. Ibises are close relatives of the herons, and the white-faced glossy ibis has not been considered a suitable game bird in other states. With the coming of the Federal migratory bird law, protection was given this bird. Large colonies still nest on tule covered islands in the larger marshes of the San Joaquin Valley.

Upland Game Birds

Grouse, quail, pigeons and doves are considered upland game, and usually a different group of hunters find their sport in these birds.

Of quail there are three types: The mountain quail with long plumes and brightly colored barred sides, the well-known valley quail with its helmet-like crest and its blue coloration, and the desert or Gambel quail, a slightly differently colored desert species resembling the valley quail. In size and beauty of plumage the mountain quail ranks first, but in desirability as a game bird the valley quail is par excellence. The first is distinctly a high mountain bird and is seldom found below 3,000 feet elevation. The Gambel quail is known only in the southeastern part of the state, where it replaces the valley quail on the desert. The California valley quail is by far the most abundant of the species. Three geographical races, or sub-species, of this quail, varying slightly in color, are recognized.

When descriptions of the numbers of quail existing twenty years ago are compared with present conditions, it must be admitted that there are many less quail at the present time. Mr. T. S. Van Dyke, writing in *Outing* in 1890, says: "The statement may seem extravagant, but for many years it was a simple matter for a good shot to bag 200 in a day, all at single shots on the wing. For several years market shooters shipped an average of 10,000 apiece for the season. This hoggish work, with the number crippled and finally killed, has greatly reduced their numbers."

Mr. C. H. Shinn, writing in the same year, in giving the records of two hunters at San Diego, says: "In eighteen consecutive hunts the smallest bag consisted of forty-seven quail and five rabbits; one of the largest bags com-

prised 187 quail, eight doves, and one rabbit, and no less than six bags ran far above a hundred quail. A Coronado gentleman shot on the wing twelve dozen quail, and a friend with him, six dozen. The best bag that this first gentleman has made in San Diego consisted of twenty-two dozen. They go in flocks of 50 to 800 and when a sportsman has studied the lay of the ground and knows the habits of the bird, he can invariably follow up the same flock with little trouble, until he has flushed and shot the greater number."

In his report on the "Birds of the Death Valley Expedition," A.K.Fisher says of the valley quail: "Throughout the San Joaquin Valley, Mr. Nelson found it common about ranches, along watercourses, or near springs. It was excessively abundant at some of the springs in the hills about the Temploa Mountains and Carrizo Plain. In the week following the expiration of the closed season, two men, pot-hunting for the market, were reported to have killed 8,400 quail at a solitary spring in the Temploa Mountains. The men built a brush blind near the spring, which was the only water within a distance of twenty miles, and as evening approached, the quails came to it by thousands. One of Mr. Nelson's informants, who saw the birds at this place, stated that the ground all about the water was covered by a compact body of quails so that the hunters mowed them down by the score at every discharge." This was in 1893. In 1917 parties from the Museum of Vertebrate Zoology of the University of California visiting the same general locality, reported that either none or but very few quail were to be seen at the watering places.

These quotations give a fair idea of the point of view of competent men twenty years ago and earlier. It is needless to call attention to the fact that in the very places mentioned by these men, conditions have changed and

quail are not nearly as numerous as they were then. In many places in the state, nevertheless, where there is little intensive cultivation, the protection afforded quail the past few years has allowed them to hold their own and in some places to increase. A short season of one month (December), a bag limit of fifteen, and favorable breeding seasons have combined to improve conditions and make the quail hunter optimistic.

Of grouse, there are three main types found within the borders of the state, the commonest of which is the sooty grouse, sometimes called blue grouse. This fine large bird is widely distributed in the mountainous districts of the state. It is seldom, if ever, found away from the shelter offered by cone-bearing trees. The bird, when flushed, rises with a startling whirr of wings and makes away with a direct rapid flight, and fast beating wings. The interesting ventriloquial call-notes in the spring have been described in another chapter. In the early days this grouse was ever present in the market but of recent years there seem to be few interested in hunting it.

The sage-grouse, or sage-hen, lays claim to being the largest grouse in North America. It is restricted to the sagebrush plateau region east of the Sierra Nevada. Because it feeds so extensively on sagebrush, its flesh is sometimes tainted and the meat made less desirable. The birds are rather easily hunted and killed, though when once started they fly very fast. Known as "fool hen" to the pioneer, it was easily struck down with the lasso of the vaquero, or easily taken on the wing with a gun. Unless too strongly tainted by the strong juices of the wormwood upon which it feeds in the winter, the bird makes a desirable dish for the table. In recent years its numbers have become so reduced that limit laws have provided smaller and smaller bag limits. At the present writing the bird is protected the year around in California with

the exception of a short season in the northeastern corner of the state where a limit of four is allowed

The Oregon ruffed grouse, very similar to the ruffed grouse of the eastern United States, has a limited distribution in California, in the four counties in the extreme northwestern corner of the state. Residents often call it a "woods pheasant." The bird is not sufficiently known nor abundant enough to be widely hunted and only a few residents of the district search it out during the short open season.

Two wild pigeons were native to America. One, the passenger pigeon, was at one time the most abundant upland game bird of the eastern United States. The history of its extinction is well known. In the western United States was found another wild pigeon with somewhat similar habits. The band-tailed pigeon of the West came near meeting the same fate as its eastern cousin but the wise framing of a federal protective law apparently saved it. This western wild pigeon is distributed from the Rocky Mountains westward to the Pacific Coast, with the exception of the desert region. California, however, has always taken care of a large proportion of those birds belonging to the Pacific Coast states, for the abundant supply of acorns has made the state a winter rendezvous. Furthermore, a considerable number of band-tailed pigeons find suitable nesting sites within the borders of the state. Unlike the eastern wild pigeon, this bird does not nest in colonies. As indicated, the chief food of the band-tailed pigeon is acorns, but many kinds of fruit are relished. The fruit of the coffee berry is so widely used by the pigeons that it is often dubbed "pigeon berry."

No other game bird has so slow a rate of increase. In California it is rare for a nest to contain more than one egg or one squab, though the finding of an occasional nest in September leads one to suspect that sometimes a

pair nests twice in a season. Undoubtedly, the band-tailed pigeon through the ages has had but few enemies. As a consequence the race has been successfully maintained with this very low rate of increase.

In early days the band-tailed pigeon, like the eastern bird, was supposed by many to be abundant enough to withstand any toll that might be levied. As a consequence, this bird was given no protection until the year 1913. Previously, with no restrictions whatsoever, band-tailed pigeons were slaughtered and sent to market, for there was no bag limit nor season. An authentic report states that in the winter of 1911-1912, one hunter shipped two thousand birds from northern Santa Barbara County to San Francisco and Los Angeles hotels. Sunday morning trains averaged one hundred passengers who were out to hunt pigeons. These passengers usually killed about thirty birds apiece. If one train load of hunters accounted for three thousand birds each week-end, what would be the estimate of the several trains concerned and the great caravan of automobiles that visited the oak-grown counties! And when it is remembered that probably most of the birds from the Pacific Coast states had concentrated in the area where there was an abundant food supply, the grave danger that attended this sort of concentrated hunting is evident.

The chief value of the band-tailed pigeon lies in its worth as a game bird. As an object of sport, it is attractive to thousands, and as might be expected from its food, its flesh is of high quality. Because of its life history and habits, it will always need special care, but it is to be hoped that this, the only large-sized wild pigeon now left in North America, will so profit by its total protection for a series of years that the declaration of an open season will be possible.

Among the game birds of California there is scarcely

one so well known as the western mourning dove. It is distinctly a bird of the open country. During the summer season it is found throughout the lowlands of the state, a few inhabit the pine belt of mountain slopes, and the low, rolling foothills of the Sierra attract vast numbers. In the winter doves are scarcer, and in certain localities they may disappear entirely. They migrate south to warmer climes, and spend the winter along the coast of Mexico and Southern California, below the latitude of Santa Barbara, and on the adjacent islands. A few winter in the Sacramento and San Joaquin valleys. This migration occurs in September, but a few birds linger until late in October.

About the first week in May the mourning dove returns to central California. At least observers report that doves become noticeably more abundant at this time. During spring and summer, mourning doves are nearly always found in pairs, but later on in the fall young birds as well as old congregate in flocks. Among all birds there are few that are so constantly seen in pairs. A scattered flock of doves will invariably resolve itself into pairs of birds.

The mourning dove has one of the longest breeding seasons of any native bird, nesting as early as February and as late as the first part of December. The height of the nesting season covers the months of March to September. A minimum of two broods is reared, and in all probability three or four nestings are occasional. The nest is sometimes placed on the ground, but more often on a limb of a shrub or tree, from four to eight feet above the ground. Cases are known, however, where nests have been built at a height of forty feet. The nest itself is a crude structure, built of small sticks laid loosely together. In it two glossy white eggs are laid. The young are fed on "pigeon milk" by a process technically known as regurgitation. They grow rapidly and are soon ready for

flight, then foraging widely for weed seeds, and taking daily flights with the adults to water.

The female mourning dove shows the greatest solicitude for her home. She is the most adept of birds at the ruse of the broken wing. When her nest is menaced she limps and flutters along the ground until the intruder is convinced that the bird is so badly injured that she may readily be caught. The deception is apparent only when the intruder finds himself led well away from the nest, and the bird takes flight in a normal manner. This habit appears to be largely limited to ground-nesting species, and it is unusual to see a bird come fluttering to the ground from a nest above. This particular instance is worthy of further study. Why this clever trick should be so markedly developed in some birds and entirely lacking in others has long puzzled scientists.

The coo of the male dove is a common sound early in the morning during the nesting season. Although made up of a succession of beautiful soft tones, yet the ensemble is so mournful that many people are disturbed by it.

Doves are dependent upon a good supply of water, and will travel many miles to drink. Because of this habit and because they fly out to the open fields for food there is usually a distinct "fly line" just at dusk when the birds are returning from feeding and watering. This gives the dove hunter an opportunity for wing shooting, and in Southern California this sport is especially popular. During the open season certain foothill districts in Los Angeles County are so populated with hunters that unhampered open places are difficult to find.

Unless favorably located near a watering-place, one bird in three or four shots makes a good average for all but the most experienced hunter. The small size and great speed make the bird a difficult target. The variety of shots possible is almost endless. Quartering and side shots

are most difficult because of the speed of the birds in flight. Then come shots at towering or descending birds, often dependent on whether they are coming or going. The easier straight-away shots are to be expected less often in dove shooting than in quail shooting.

Thus it will be seen that dove hunting gives the best of practice to the lover of wing shooting. No finer test of skill is afforded unless it be in snipe shooting. The gunner who desires to test his marksmanship on doves is assured of a savory reward though insignificant in amount, if he proves his skill, for the young birds are tender and delicious.

In defense of this sport the hunter rightly argues that doves are abundant, very prolific and capable of rapid recuperation; that rapid flight and a quick response to danger sufficiently protect them. Despite this argument there has been a growing sentiment of late that this bird should be taken from the list of game birds and protected throughout the year. Although of excellent flavor, the mourning dove can hardly be considered a desirable game bird because of its small size. When its esthetic value and its service to the agriculturist are taken into consideration the plea for total protection is partially justified at least.

Rodent poisoning operations have in recent years been responsible for the death of many doves; for, unlike the quail, the mourning dove and the band-tailed pigeon are both susceptible to strychnine, and, although the loss from this cause may not be great, it is unfortunate that it exists at all.

The mourning dove is to be numbered among those birds against which practically no complaint is made regarding depredations upon growing crops.

In the case of no other game bird in California has the general conservation principle of safety during the breeding season been so continuously violated. Mourning

doves often nest in September and an open season beginning before the fifteenth of this month is to be deprecated, for it allows the killing of nesting birds. For many years, beginning in 1880, the dove season opened on July 1 and closed on January 1, an open season of six months. Since that time many changes have been made, but in deference to the sportsmen, who claimed that the doves leave the Great Valley before September 1, the opening date was invariably set back, usually to July 1. Even as late as 1907 the season opened on July 15. Since 1911, the dove season has opened on September 1. A reduction to three months and then to one month in Northern California, and to two months in Southern California, has had beneficial results.

Introduced Game Birds

Many have been the endeavors to introduce worth-while game birds. Previous to state endeavor along these lines, many private individuals had attempted propagation and introduction. Some of these ventures were attempted as early as 1893. A number of pheasants were purchased by the Fish and Game Commission in Oregon in 1894 and given wide distribution. In 1908 the commission purchased 3,500 Hungarian partridges, some of which were used for breeders at the game farm. Other early efforts included the attempted introduction of the Chinese quail, bob-white, Gambel quail and several species of Mexican quail. In all, more than a dozen species of game birds were introduced. From 1908 to 1916 numerous pheasants and quail were reared on a game farm at Hayward and distributed widely. Wild turkeys were also reared. In most instances, these introductions were followed with optimistic reports of success, but, with the exception of the ring-neck pheasant, none of these birds established themselves.

In the fall of 1924, 5,600 young ring-necked pheasants were purchased in Washington and liberated in Inyo, San Diego and Stanislaus counties. Favorable reports have been obtained of these introductions. After nearly a ten-year period of inactivity in the direction of propagation a new, modern game farm was established at Yountville, Napa County, and an extensive program entered upon to care for the demand for upland shooting. Fortunately, the plan contemplates stocking of cultivated areas rather than the introduction of competing birds in natural cover.

The whole Yountville farm is made vermin-proof by means of a fence and wire roofing. The 472 pens, each 24x24 feet, make it the largest of game farms. By a system of sprinklers half of each cage is kept moist enough to grow a cover crop which attracts insect life, and the other half of the pen is kept dry.

The output is increasing yearly, reaching more than 8,000 birds in 1927. A second game farm in Southern California is contemplated. Sportsmen now look forward confidently to an open season on pheasants.

Though experiments with valley quail, bob-white, and Hungarian partridges show that these birds are difficult to rear, yet persistent efforts are to be made to bring success.

Successes in Oregon, Washington and British Columbia give California sportsmen encouragement. If the state, with a long history of past attempts, can now profit by its mistakes, time and energy will not be wasted and California will line up with other states that have been successful in the establishing of exotic game birds. Nothing in recent years has shown so earnest an attempt at improving hunting conditions as the move to propagate game birds in large numbers.

Chapter IX

CHAPTER IX

The People's Playgrounds

And there were gardens bright with sinuous rills
Where blossomed many an incense bearing tree,
And here were forests, ancient as the hills,
Enfolding sunny spots of greenery.

—*Kubla Khan.*

THE NATIONAL parks of America had their true beginning in 1872 in the establishment of Yellowstone National Park, located in northwestern Wyoming. An area of 3,348 square miles was set aside as a public park because it exhibited spectacular volcanic phenomena. Included within its borders is one of the most extraordinary groups of geysers known in the world, and in addition, boiling springs, mud volcanoes, petrified forests and wonderful lakes, streams and waterfalls. Part of it is still a vast wilderness comprising one of the greatest wild bird and animal preserves in the world. Even previous to this, in 1832, Hot Springs, Arkansas, was made a park because of the remarkable radio-active properties of the water.

In 1890, three national parks were set aside in California, two of them to commemorate fine groves of big trees, and the other one to save from exploitation immense

granite cliffs, waterfalls of extraordinary height, great forests and beautiful lakes and streams.

At first, national parks were administered by the War Department, and troops of cavalry carefully guarded each park. Later they were placed under the supervision of the Department of the Interior, and in 1917, the National Park Service was made an independent bureau of this department. Beginning on this date, all of the parks, which had then increased to fifteen, have been administered by this bureau, each supervised by a resident superintendent and guarded by park rangers.

A definite policy regarding their purpose and administration has been formulated as follows:

"The purpose in creating parks is to preserve the scenery, the natural and historic objects, and the plants and wild life. The objects are the enjoyment of the people, and the aiding of education and scientific study by keeping such areas unimpaired. Thereby certain portions of nature's handiwork will be kept for recreation, for science and for education, both for this and for future generations."

There are basic differences between national parks and national forests. National forests are created to administer lumbering and grazing interests for the people, the trees being cut in accordance with the principles of scientific forestry. Grazing is permitted in national forests under governmental regulations, while in the national parks grazing is permitted only where not detrimental to the enjoyment and preservation of the scenery. Hunting is permitted in season in the national forests but never in the national parks, which are permanent game sanctuaries. In short, national parks, unlike national forests, are not properties in a commercial sense, but natural preserves for the rest, recreation and education of the people. They remain under Nature's own chosen conditions.

"National Parks are areas of original unmodified con-

ditions each the first example of its scenic type in the country, preserved as a system from all industrial use." This is the official definition.

At the present time there are nineteen national parks with a total area of 11,739 square miles and varying in size from one half square mile to 3,348 square miles. Together they include scenic features of unsurpassed magnificence and variety. The western mountainous area of America has the greater proportion of these parks and, in recent years, one has been established in Hawaii and one in south central Alaska. They are completely conserved in a condition of primitive nature, constituting a "system of National Museums of natural wilderness landscape where wild life receives complete protection."

The invitation to the national parks reads thus:

To the American People:

Uncle Sam asks you to be his guest. He has prepared for you the choice places of this continent—places of grandeur, beauty and of wonder. He has built roads through the deep-cut cañons and beside happy streams which will carry you into these places in comfort, and has provided lodgings and food in the most distant and inaccessible places that you might enjoy yourself and realize as little as possible the rigors of the pioneer traveler's life. These are for you. They are the playgrounds of the people. To see them is to make more hearty your affection and admiration for America.

—Franklin K. Lane, Secretary of the Interior.

Staunch friends of the national parks have saved them from spoliation by commercial interests. Exploiters having driven an entering wedge by securing the water rights in Hetch Hetchy Valley, a part of Yosemite National Park, succeeded in having Congress hastily pass a Water Power Act which constituted the Secretaries of Agricul-

ture, Interior and War a commission to lease all public waters, including those in national parks and monuments. No sooner was this law enacted than applications were promptly made for storage reservoirs and power house sites on Merced Lake in Little Yosemite, for the diversion of Buena Vista and Illillouette creeks, for reservoirs in Virginia and Tuolumne cañons, desecrations which could only be exceeded by damming Yosemite Valley itself.

Likewise, for several years there was a concerted effort to seek legislation changing the boundaries of Yellowstone National Park to allow the building of great storage reservoirs as a basis for an irrigation project in Idaho. Conservationists rightly feared the precedent that might be thus established of cutting large areas out of national parks to serve local utility demands.

It took a long fight to restore the parks to the control of Congress and when this was secured it was on the basis of the present parks. The question will have to be brought up with every new addition to the park system. Secretary of the Interior Payne remarked when this fight was on: "When once you establish the principle that you can encroach on a national park for irrigation or water power, you commence a process which will end only in the entire commercialization of them all." If defenders of national parks are caught napping administrative changes may be inaugurated that will alter the whole intent and purpose of the nation's gallery of scenic masterpieces.

California is rich in national parks, for four have been located within her borders. These parks cover an area of 1,857 square miles, considerably more than a million acres. The most noted one, Yosemite, preserves for posterity an immense granite wilderness, containing world-famous glacial-cut Yosemite Valley with its giant cliffs and waterfalls of extraordinary height, and magnificent forests of cone-bearing trees; two of them, Sequoia and General

Grant, conserve the finest forests of giant big trees in the world, together with fine Alpine summits including Mount Whitney, highest peak in the United States exclusive of Alaska, and the stupendous cañon of the Kern River. The fourth, Lassen Volcanic, saves for public use the only active volcano in the United States proper, together with such volcanic manifestations as cinder cones, hot springs and mud geysers. A number of lesser attractions are located within the national monuments: Muir Woods, Pinnacles, Devil's Postpile, Cabrillo and Lava Beds.

Yosemite National Park

In describing Yosemite Valley we must deal with superlatives. Even a world-traveled geologist has described it thus: "No other valley is so remarkably fashioned; no other valley holds within so small a compass so astounding a wealth of striking and distinctive scenic features. As a whole, it is a broad rock-hewn trough with parallel sides, boldly sculptured and ornamented with silvery cataracts. The level floor, whose groves and meadows afford ideal places for camping and other forms of recreation, lies 4,000 feet above the sea, and the forested uplands on either side rise 3,000 to 4,000 feet higher." Yosemite Falls is the "highest unbroken plunge of water on the continent"; probably the highest in the world. We must now add to this galaxy of superlatives the three greatest granite monoliths in the world: El Capitan, Half Dome, and Mount Watkins.

A great glacier left Yosemite Valley, the valley incomparable, a deep gorge with perpendicular granite walls rising 3,000 feet on each side. The valley itself is but seven miles long and from one half to one mile wide. Over these granite walls pour a number of waterfalls, the highest and most beautiful on the continent. A picturesque

meandering river, the Merced, flows through a wonderfully forested flat valley floor. At intervals along the walls are outstanding prominences, originally named by the Indians but now bearing such American names as Cathedral Rocks and Spires, The Three Brothers, Sentinel Rock, North Dome and Half Dome.

Of the three greatest outstanding masses of granite, El Capitan is the most impressive, with Half Dome and Mount Watkins to be found up the side cañon of Tenaya Creek as lesser lights. This magnificent monolith which helps to form the gateway of the valley, has a sheer face of three thousand six hundred and four feet. The granite is but little weathered and one is awed by the appearance of mass and strength. Gibraltar is not even half as high.

Half Dome is a remarkably shaped summit which divides the main Merced River from its tributary, Tenaya Creek. Its name indicates its peculiar shape. Though one cannot find the broken half at its base, the standing dome gives the appearance of having half of it split off. It has been described as "the most colossal and most strangely modeled rock monument in the Sierra Nevada." Smoothly rounded on three sides, the fourth, which faces the valley, presents a sheer wall of at least a thousand feet. This mass of granite rises 4,850 feet above the valley floor.

The highest peak on the rim of the valley is known as Clouds Rest, a long crest, like a lizard's back, which towers 9,929 feet above sea level. The Alpine flora of its summit indicates that timber line has been passed.

The most conspicuous waterfall is formed by Yosemite Creek, where it drops 1,430 feet in one sheer fall, and then after a cascade of 815 feet drops another 320 feet to the valley floor. The celebrated Bridal Veil Falls is 620 feet in height but does not carry the volume of water of Nevada Falls, 594 feet, and Vernal Falls, 320 feet, which are on the main Merced River. The highest fall of all, Ribbon

Falls, drops 1,620 feet, nearly ten times that of Niagara, but the volume of water is small and it does not fall free from the lip. In dry seasons Yosemite Falls disappears in late summer but most of the others are perennial. They are at their best the end of May when streams are in flood.

There has been much discussion as to whether the waterfalls of Yosemite are in reality the highest in the world. Mr. F. E. Matthes, after collecting data on waterfalls the world over, asserts that the Upper Yosemite Fall is far in the lead as the highest single unbroken leap of water in the world. This leap measures 1,430 feet. The closest competitor for honors is the Sutherland Fall in New Zealand which measures 1,904 feet. However, this fall is broken midway by projecting ledges and makes no clear leap of more than 900 feet. As soon as comparison is made with falls where there is not a clean drop, one is allowed to add the cascade and lower fall of Yosemite, making a total drop of 2,565 feet.

Within Yosemite National Park are three groves of big trees. The Tuolumne Grove, though small, is easily accessible via the Big Oak Flat road. Another small one, the Merced Grove, is seldom visited because isolated from main routes of travel. The larger and more noted grove is located near Wawona and is called the Mariposa Grove of Big Trees. This is the greatest grove of giant Sequoias outside of Sequoia National Park. The largest tree in the group, known as the Grizzly Giant, has a girth of ninety-three feet, a diameter of twenty-nine and six-tenths feet and a height of two hundred and four feet. Its age is estimated at near 4,000 years. If a hole were cut through this tree, as has been done in the Wawona tree, a wagon and two street cars could drive through side by side and still leave strong enough supports for the tree on each side. This is the third largest tree in the world. The Washing-

ton tree lacks but three inches of equaling the Grizzly Giant in diameter.

The valley proper has a notable addition in its tributary Tenaya, which is one of the grandest of cañons with walls 4,000 to 5,000 feet in height. To the east a polished granite slope of more than 5,000 feet is crowned by Clouds Rest. Between this wall and that of Mount Watkins on the west, the creek has cut a deep box cañon at the head of which a 500-foot waterfall drops over polished granite. This, and Muir Gorge on the Tuolumne, before the trail was built, were considered the hardest of cañons to negotiate. Only a few hardy mountain climbers attempted them, and then only at low water.

Above the two famous waterfalls, Vernal and Nevada, lies a miniature Yosemite Valley, known as Little Yosemite Valley. The river winds through a forest of lodgepole, yellow and sugar pine, and near at hand great granite walls with outstanding domes limit its flat floor. This less visited valley has much distinctive charm.

Yosemite Valley is but a small part of Yosemite National Park which covers 1,125 square miles. In the summit region stand marvelous snow-capped peaks, the highest and the most noted of which is Mount Lyell, 13,090 feet in height, the southernmost Sierran peak possessing a living glacier. On its slopes we find the sources of two great river systems, the Tuolumne and the Merced. Lakes of great beauty, well supplied with fish, and which consequently tempt the angler, are abundant in the high country. No less than forty-two are discernible from Red Peak.

Though formerly the summit region could be reached only by knapsackers or by pack train, it has in recent years been made available to all through the establishment of hikers' camps, placed ten miles or less apart. At these camps simple accommodation may be had at reason-

able prices and the hiker, without encumbrances of sleeping bag and food supply, can follow well-built trails and reach a desirable stopping place each night. From these high mountain camps the higher peaks can be climbed and the hidden lakes explored. The famous Waterwheel Falls and Muir Gorge on the Tuolumne have thus been made readily accessible.

Though the Joseph R. Walker expedition descended the rib between the Merced and Tuolumne rivers in 1833, and probably looked down into Yosemite Valley from its northern wall, there is no evidence to show that white men entered Yosemite Valley until the spring of 1851. At this time a group of miners, organized as the Mariposa Battalion, a part of the State Militia, followed a band of Indians into the valley. The expedition had been formed because of Indian raids and because the chief of the Yosemites had failed to treat with the Indian Commissioner. The day of the discovery was March 25, 1851. As the campaigners sat about the campfire, the first night in the valley, Dr. L. H. Bunnell suggested the name of Yosemite Valley, the name given the Indian tribe, rather than the more melodious Indian name, Ahwahnee, given it by the Indians. A second expedition was sent to the valley on May 4, 1851, this party remaining for two weeks. It was not till several years later, early in 1855, that J. M. Hutchins, publisher of the *California Magazine*, entered the valley and began the publication of articles which made Yosemite known to the world. Yosemite National Park has been both a state and a national park and has had its boundaries changed on several occasions.

The true grandeur of the Sierra Nevada, though having been thus early brought to light, was not quickly appreciated. It was many years before travel was sufficient to demand development. Access was to be gained only by

covering rough trails on horseback. A few people found their way into Yosemite Valley during the early fifties and through the years visitors have increased to the point where the annual travel record nearly reaches a half million. Now it is the best known and most frequented of the national parks with the possible exception of Yellowstone. Accommodations to fit every purse are provided. One may furnish one's own equipment and have free camp grounds; may have American plan camp accommodations, or stay at one of the most beautiful and well equipped hotels in the United States.

Physical development has been great in more recent years. There are now more than six hundred miles of trail and more than three hundred miles of auto road. The roads in the Valley are paved; bridges are of cement. A trans-Sierra route is maintained. Buildings of beauty house the administrative staff. A club-house and neat cottages furnish quarters for employees. Crowds are well handled and the back country patrolled by rangers. The educational side has likewise received attention. A splendid natural history museum affords the visitor opportunities for study. A nature guide service schedules field trips where interested visitors may meet and learn first-hand about trees, wild flowers, birds and animals, and hear lectures designed to teach all concerning the scenic features and natural history of the park. In reality a trail school is provided, the students of which may choose a short or long course, for trips vary in length from a couple of hours to a day, and even to a whole week's trip around the hikers' camps. Instruction by the nature guides is free.

Another notable contribution to the educational use of national parks was made when the Yosemite School of Field Natural History was established in the summer of 1925. Though the work given is of university grade, no university credit is offered. The course is designed to be

supplementary to biology courses given in universities. Whereas in university courses, work is based on lectures and laboratory work, this mountain summer school places emphasis on intensive field work, and first-hand acquaintance with living things is the main requirement; the nature guide staff, which contains a number of specialists, comprises the teaching staff. Opportunity for practice in teaching, leading parties afield, in presentation of nature lore at the camp fire and in writing nature notes, is given each student. This school, which places so much emphasis on a study of living things rather than upon the dissection of dead animals taken from their original environment, attracts a fine group of teachers and other nature students each summer. The course ends with a week's trip spent in making studies at timber line. The students live together in a group of tents where they readily learn from each other. Those who have taken it persist in stating that it is the most stimulating course they have ever enjoyed.

Certainly a national park where nature is to be seen in her original condition is the best place for a school of this kind, and certainly a group of trained students who go back to their work each year with added knowledge as to the natural history of a national park and as to conservation needs and methods, will spread national park ideals and exemplify the educational opportunities offered.

Sequoia National Park

In name and reality Sequoia National Park is the Big Tree National Park. Here may be found several hundred Sequoia trees over ten feet in diameter and some that range from twenty-five to thirty-six feet; but this does not describe the park. Scenic features are endless. The forests are magnificent. The upland meadows are flower-grown.

Rushing streams are on every hand. The forests stretch up to the granite peaks, many of them snow-capped. In 1926 the park was enlarged to include the crest of the Sierra, so that it now contains 604 square miles as against 252 square miles of the former park. It now has within its boundary Mount Whitney, much of the stupendous cañon of the Kern, the Kaweah peaks, and the imposing ridge known as the Great Western Divide.

The largest grove of sequoias is known as the Giant Forest and with its General Sherman tree it is rightly the center of attraction. Here a summer population of 1,500 gathers to enjoy the association with these oldest and largest living things. There is no jazz atmosphere allowed. This park is noted for its simple, homey accommodations and entertainment, all conducive to a worshipful attitude.

Again we turn to John Muir for a fitting description: "It extends, a magnificent growth of giants grouped in pure temple groves, ranged in colonnades along the side of meadows or scattered among other trees, from the granite headlands overlooking the hot foothills and plains of the San Joaquin back to within a few miles of the old glacier fountains at an elevation of 5,000 to 8,400 feet above the sea."

Of the many mammoth trees in Sequoia National Park, the General Sherman is the largest and best known. But there are hundreds of others which vie with it in interest and beauty. A hunter and trapper named Wolverton discovered this tree August 7, 1879, and named it for the famous general under whom he had served in the Civil War. The dimensions are: height, 280 feet; base circumference, 102.8 feet; base diameter, 32.7 feet; greatest diameter at base, 36.5 feet; circumference six feet above ground, 86 feet; diameter six feet above ground, 27.4 feet; diameter 100 feet above ground, 17.7 feet. It should take nothing

more to convince one that this is the world's biggest tree. The Cloister is the name given a fine group of four trees. A large circle of them is named the Congress Group. The most beautiful big tree in this forest has been named after Roosevelt.

The following appeal greets tourists who visit the oldest trees in Sequoia and General Grant National Parks:

"Friends:

"This is one of the oldest and largest living things on earth. This tree was in lusty growth when Christ walked in Palestine; when Moses gave the Ten Commandments to the Hebrews, it was a sturdy young tree, a few hundred years old; when the cohorts of the Assyrians descended on Greece, and when Cheops built his pyramid, it was already thrusting a slender spire of tender green into California's blue sky.

"Treat this tree with the reverence it should inspire. Do not deface nature's largest and oldest living monument by carving your name, by removing the smallest particle of bark, or by trampling down the natural protective covering over the roots. What one person might be permitted to do with insignificant damage to the tree must not be done by many thousands.

"We ask your cooperation in preserving this grand old man in his patriarchal perfection for the admiration of your children and your children's children.

"JOHN B. WHITE,
"Superintendent."

The Giant Forest composed of big trees is not the only forest contained in Sequoia National Park. The main forest belt is many miles wide and many coniferous trees are represented. From the yellow pine belt through the red fir belt, the trees are of splendid size. At higher elevations the dwarf trees of timber line are more scattered

and do not produce the thick forests found at lower elevations. The lodgepole pine or "tamrac pine" is the tree which forms the most extensive forests and has the widest range. Though it usually borders streams, lakes and mountain meadows, it often chooses inhospitable places on exposed ridges almost to timberline. The high, well-timbered plateaus have a rugged beauty of their own though the trees are inferior in size. Here grow the finest known stands of the foxtail pine. The highest ridges stand out above the timber line with a few stunted tree stragglers marking the farthest advance. High mountain lakes and flower-grown meadows nestle in the glacial cirques at the foot of the jagged granite peaks, with their snow fields. There are nine peaks, exclusive of Mount Whitney, which are over 14,000 feet in height and numerous others, such as Mount Brewer and Kaweah peaks, which, though lower, are equally impressive. An extensive trail system makes the best of the scenery accessible.

When the national parks were created some patented land was necessarily included. Sequoia National Park was for many years handicapped by private holdings in the heart of the park. Stephen T. Mather, the capable Director of National Parks, should be credited with engineering several purchases which have greatly helped in the administration of this park. Congress has seldom shown an inclination to purchase such privately owned land. On the other hand, there have been many gifts by public-spirited citizens. The latest gift of this kind is that of the National Geographic Society, a presentation of 2,400 acres, the largest of several gifts which have totaled in value $93,000. The Sierra Club is holding in trust important land in Tuolumne Meadows in Yosemite National Park, thus saving it from exploitation.

General Grant National Park

General Grant National Park is the smallest of the four. Situated only a few miles north and slightly west of Sequoia National Park, the two have until recently been connected by trail only, but now an automobile road spans the ridges between. Good roads have long led eastward from Fresno, which is located in the geographical center of California. In addition to the grove of big trees which includes the remarkable General Grant tree, there are many scenic features: beautiful streams, forests, unique rock formations. If for no other reason, this park would be famous because it holds the second largest tree in the world, the General Grant tree. Its height is 264 feet and its diameter 36 feet.

Lassen Volcanic National Park

Lassen Peak and its nearby cinder cone were considered of sufficient interest to be made national monuments during the Taft administration. However, the sudden bursting into activity of the volcano in 1914 and 1915 so changed the viewpoint of Congress, that a sizable area of 124 square miles was set aside and called Lassen Volcanic National Park by an act of Congress approved August 9, 1916. This park more than any other displays great physical changes that have occurred on the earth's surface in recent centuries. In addition to Lassen Peak, there are nearby several 9,000-foot mountains and numerous smaller volcanic peaks and fantastic lava fields; of still greater interest are fumaroles, hot springs and mud volcanoes. Cinder Cone, bare of vegetation, is so perfect in shape that it must have been of fairly recent formation. Study of the growth rings of forest trees near the edge of the lava flows indicate that there was considerable activity about the year 1771.

A dozen fine lakes are found within the park. One of them, Juniper Lake, is especially noted for its large steelhead trout. Another, Snag Lake, is beautifully surrounded with forests.

A visit to this newest of California's national parks, the Lassen Volcanic, will always bring with it the possibility of seeing a live volcano. Lassen Peak rises to an elevation of more than a mile above the ancient sedimentary rocks on which it rests. Stretching to the northward lies one of the greatest lava fields in the world. Though early explorers saw an eruption of Mount Baker in the State of Washington, and though Mount Rainier and Mount Shasta emit heated vapors from the fumaroles on their summits, giving evidence that their interiors are still hot, yet Lassen Peak has furnished the most typical volcanic activity, and it is to be counted as an active volcano.

The upbuilding of Lassen Peak, according to geologists, began near the close of the Eocene period. Lava flows were largest and most numerous in Miocene and Pliocene times. Undoubtedly long periods of interrupted activity separated by intervals of quiescence explain the formation of cinder cones and beds of tuff as contrasted with the lava fields formed by lava flows. At least three main craters have been active in the past, and it is a fourth that is performing at the present time. This crater is exceptional because of its low energy, small mass of material erupted, and the continuity of the activity. Two phases have been noted: one explosive, the other effusive. In the first phase explosive eruptions were the rule; in the second phase lava overflowed to the west. Since the beginning of activity in 1914, there have been more than two hundred eruptions; most of them evident at a distance because of clouds of steam and smoke. Strange to say, such active volcanic features as those of Bumpass'

Hell, the Devil's Kitchen and Boiling Lake, which have so long excited the interest of visitors, have shown little or no change in amount of activity during the last fifty years. Apparently they have not been affected by the eruptions at the summit of the peak four thousand feet above them.

In 1915 eruptions were numerous, but they have been few and far between ever since. A new crater from 700 to 1,000 feet across was first blown out. Some idea of the force displayed is evidenced by the fact that one stone fifteen feet in diameter and weighing about sixty-three tons was thrown out of this crater. Smaller stones landed more than a mile from the crater and lighter material still farther. Following these explosive eruptions came a great flow of lava on May 22, 1915, that filled the crater and flowed down the slope of Lassen Peak about a thousand feet. This was accompanied by steam and beautiful night displays of light. The heat from the lava was intense and according to observers the air above it shimmered with heat waves.

Another interesting phenomenon occurred on the night of May 19, 1915, when superheated gases melted the snow on the northeastern slope and rushing waters devastated a mile-wide belt down Lost Creek and Hat Creek. Three-foot trees were broken off or uprooted and meadows were buried beneath debris. Trees that remained standing were scorched and even charred by the blast and at least two fires were kindled by the hot gases. A number of fumaroles developed on the north and west slopes of the peak within 800 feet of the summit.

J. S. Diller, noted geologist, thus sums up the situation for the person interested in geology:

"With its comfortable active volcano, inviting cinder cones and lava fields, vigorously boiling hot springs, mud lakes and 'mush pots' for the volcanologist to study, and

the glaciated divides for the physiographer, in a setting of lovely scenery and attractive camps for the tourists, all easily accessible, the Lassen Peak region affords one of the most alluring and attractive spots for a National Park."

Eventually another national park, to commemorate the coast redwood, will be added to California's parks. In accordance with a resolution passed by Congress in 1920, surveys have been made and the problem studied extensively. A primeval forest possessing the scenic features most characteristic of the redwood region will be chosen. Requirements will include: an area truly representative of the redwoods in their maturity; one of adequate size—probably not less than 20,000 acres; and one accessible, and with adequate opportunities for recreation. The groves along the approach to this national park will be preserved through private donation and through state and county appropriations, ultimately making a "Highway of the Giants," extending from their southernmost limit to their northernmost, and connecting the various groves and parks.

Within the national parks the public is led to seek spiritual reinvigoration, intellectual stimulation and physical strengthening. No other country in the world has so definitely recognized the need of specially created areas for such use by the public. The system of national parks is a "unique expression of combined idealism and practicality" which helps to make the nation great.

National Monuments

It was in order that objects of historic or scientific importance, in smaller areas than those of national park size and standards, might be conserved, that national monuments have been created by presidential executive order. They total fifty-six, thirty-two of which are administered

by the Department of the Interior, fifteen by the Agricultural Department, and nine by the War Department. Included among the national monuments are distinguished ruins of prehistoric civilization, and outstanding geologic phenomena. Existing national monuments may be classified as follows:

Prehistoric ruins, 13; historic buildings, 16; geologic areas, 23; areas preserving wild life, 3.

There are five national monuments within the borders of the State of California. In 1908, the spire-like rocks in San Benito County known as the Pinnacles were thus set aside. These rocks stand from 600 to 1,000 feet high and because of their jagged character catch the eye at a distance. Caves which may be explored by the light of a candle or flashlight are an added attraction.

In the same year a fine virgin stand of coast redwoods in Marin County on the flanks of Mount Tamalpais became a national monument through the gift of William Kent.

A spectacular mass of basaltic columns, some of them piled like cord wood, was designated a national monument in 1911. This monument is located on the main fork of the San Joaquin River, most easily reached from Mammoth, Mono County.

Point Cabrillo became a monument in 1913. Only one acre of ground is included. Point Cabrillo is the headland which was originally sighted in 1542, marking the discovery of the California coast.

Historically and geologically the Lava Beds in Modoc County, set aside by President Coolidge, deserve to be recognized as a national monument. Inscriptions and paintings on the rock indicate the culture of the primitive Indian of this region. It was here, in 1873, that Captain Jack made his last stand during the Modoc Indian War when General Canby and many soldiers were killed. It

is a typical example of the great lava flows which cover much of the Northwest. Though but poorly explored, more than a hundred caves have been mapped. Fauna and flora are distinctive. The monument includes 46,967 acres or 73 square miles.

State Parks

California has lagged behind in its state park program. When the bill creating a Division of State Parks was passed in 1927, only five state parks had been set aside: Redwood State Park, Mount Diablo State Park, Burney Falls State Park, Humboldt State Redwood Park and General Bidwell State Park. With the unification of separate commissions into a State Park Board, under the Department of Natural Resources, an ambitious program was inaugurated. With the fulfilment of plans, California will have a splendid system of well-regulated state parks which will supply local recreation grounds for neighboring communities. It is probable that a number of the national monuments will eventually become state parks.

Redwood State Park was established in 1905 when the State of California purchased 2,500 acres of virgin redwood in that portion of the Santa Cruz Mountains known as "The Big Basin," about twenty-five miles north of Santa Cruz. Another 1,200 acres have since been purchased and two tracts of 160 acres each have been donated by private owners. Approximately 4,000 acres were added by the Federal Government making a total of about 9,000 acres of land in the park. Among the fine specimens of coast redwood are a number of trees that measure twenty-one feet in diameter. This park is a popular camping ground for many Californians. Nearly three hundred camp sites have been provided and they are well filled during the summer months. Foot trails allow exploration. Since the park is maintained in as near a state of nature as is

possible, succeeding generations will be able to judge of the character of the original redwood forests of the coastal region of California.

A beautiful waterfall on Burney Creek on a tributary of the Pit River forms the scenic feature for Burney Falls Park. An area of 160 acres in Shasta County was purchased by Mr. Frank McArthur and donated to the state as a park. Situated about five miles off the main highway, this park should prove a lasting attraction in the northern part of the state.

By legislative act, Mount Diablo State Park was created on June 3, 1921, owing to demand by the Native Sons of the Golden West. This park covers a small area only on the summit of Mount Diablo in Contra Costa County. The peak is nearly 4,000 feet high, the highest in the San Francisco Bay region, and was used by the early geologists as a meridian indicator. As yet few improvements have been made, but the locality is of sufficient interest to attract large numbers of people. A good road leads to the summit.

Humboldt State Redwood Park is a splendid stand of redwoods located in Humboldt and Del Norte counties. Its creation resulted from activities of the Save the Redwoods League.

General Bidwell State Park is a portion of a pioneer's old ranch in the Sacramento Valley near Chico, Butte County. It contains some typical native stream-side vegetation, together with some agricultural land.

Several tracts of redwoods in Humboldt and Mendocino counties held in trust by the Save the Redwoods League will eventually become state parks. There is demand for creation of a sizable state park, about 12,000 acres, to include Mount Tamalpais and nearby recreation grounds of the bay cities.

National Forests

California is a well-forested state. Forests cover twenty-two per cent of its total area. The lumberman would point out that there are two hundred billion feet of standing timber.

It is now well known that forests are more than a timber resource. Water supply is very definitely tied up with forest cover. Any state with arid valleys such as those possessed by California must prize her forest resources more largely from a standpoint of water supply than that of merchantable timber. The whole prosperity of the West has been dependent upon the supply of water obtainable for irrigation, for there is more tillable land than there is water to irrigate it. Even though most national forests are located in the mountains far away from the fertile valleys, it is the tree growth that assures the water supply which nowadays may be carried hundreds of miles to its ultimate users. Anything which conserves the water supply is a support to navigation and navigable rivers make cheap transportation. An adequate supply of water in the mountains is the basis of hydraulic power development, the life blood of manufacturing enterprises.

In the final analysis it is the forest which prevents a rapid run-off of the annual supply of water. The flow of streams is thus regulated. Through the aid of trees the soil is made to act as a great reservoir which slowly feeds the springs and streams so vital to every resident. Practically all of the rain that falls on a burned area quickly reaches the river, and with the water go tons of debris and ashes, and most of the soil. A black roaring torrent rushes down to the valley to obstruct the channel and irrigation ditches, and to wash out roads and bridges. The following summer when water is needed most of the

stream dries up. If water is held back by brush or forest cover of the hills and mountains, continuous stream flow is assured.

The state's forest resources were being markedly reduced when a wave of conservation swept the country which resulted in the establishment of national forests, a step of first importance toward public ownership. Though the first legal steps toward the formation of national forests were taken in 1891, the areas were not properly organized until 1905. As early as 1850 there had been talk of forest conservation in California, but beyond a survey of conditions at Lake Tahoe, a survey of the forest problems of the state, and the appointment of a Board of Forestry in 1885, nothing constructive was done until the Federal Act of 1891, creating forest reserves (since 1905 called national forests) was passed. In 1892, there were four national forests in California; at present writing there are eighteen. Within these forests are the main bodies of timber and important water sheds of the Sierra Nevada, the Coast Range and the Sierra Madre. Counting about 500,000 acres lying over the boundary line, these eighteen forests contain 19,000,000 acres of government land.

National forests are created to protect and maintain in a permanently productive and useful condition, lands unsuited to agriculture but capable of yielding timber or other general benefits, such as forage for livestock and water for irrigation, domestic use, and power. All of the resources of the national forests are developed and used to the greatest possible extent consistent with permanent productivity under the principle of coordinated use. Camping and hunting and fishing in season are permitted in the national forests of California, but a camp-fire permit must first be obtained before any form of outdoor fire,

including fire in stoves burning wood, kerosene, or gasoline, is built on government land.

National forests are administered by the United States Forest Service, a bureau of the United States Department of Agriculture. District 5, one of the seven administrative districts of the country, has its headquarters in San Francisco with a District Forester as directing head. Each forest is administered by a resident supervisor and a local staff of clerks and rangers.

Lest there be too much criticism that the states in which national forests are located receive no profits from untaxable Federal land, an arrangement has been made whereby one quarter of the total income from national forests goes back to the local county for schools and roads. Here in California about $700,000 per year is thus returned for the benefit of the surrounding population. Another ten per cent of the income is spent on trails and roads.

Forests differ greatly from north to south. The coastal redwood forest is one of the densest and most imposing in all the world. The trees stand so close together and produce such abundant shade that the ground cover is always moist and only ferns and shade-loving plants are able to grow. In contrast is the meager vegetation on the desert slopes of the mountains in Southern California, where the cañons alone produce sparse growths of cottonwood, sycamore and other stream-side trees. The great forests on the western slope of the Sierra Nevada may perhaps be described as between these two extremes.

The northern group of national forests contains fine stands of timber and mighty resources in power; lakes and streams of great beauty draw the vacationist. They comprise the hunting grounds of the sportsman.

A tourist from some eastern state is sometimes surprised on entering a signed boundary of a national forest in Southern California, for he finds little real forest, the

mountains being covered with only an elfin forest of chamise and manzanita and a few scrub oaks. On the distant mountain tops may be seen a fringe of pines and on some north-facing slopes some big-coned spruce, but nowhere are there extensive forests such as those in the Sierra Nevada. At every stream crossing there is evidence of winter freshets: débris left high up in the willows and alders, tumbles of boulders well above the edge of the quiet peaceful stream which trickles through the sand and rocks. Along some of the larger streams one finds a cable stretched across with a suspended car reserved by miners to assure a crossing when the stream is high. The toll claimed of unwary persons when these streams are in flood has taught survivors caution. Follow the national forest road which leads first up a cañon, then along a ridge, giving views of ridge behind ridge, and you finally reach a camp ground among the pines alongside a fine stream. Here rangers have provided many conveniences: benches, tables, water. Your tent up and a sleep under the stars, and you are ready to follow the trail to the high peak near at hand which gives a view in every direction. The valley may be covered with fog or show its checker-board pattern of field and orchard. Your road, your trail, your camp, your entertainment were gifts from Uncle Sam through the medium of the United States Forest Service, that efficient bureau of the United States Department of Agriculture.

These chaparral-covered mountain slopes constitute a resource almost as great as a stand of timber. They are responsible for necessary water supply and hydro-electric development for an arid region and a rapidly growing population. True, little timber is merchantable; firewood, on the other hand, becomes the more salable product.

"The timber crop of the national forests is not harvested by the Government but by the lumbermen who buy

'stumpage' under competitive bids. Cutting is done in accordance with the terms of carefully prepared contracts, and all trees to be cut are marked or designated by qualified forest officers. Thrifty trees and reproduction are left to furnish seed and form the basis of a future crop. This represents from fifteen to twenty per cent of the original stand and will furnish a second timber crop in from fifty to seventy-five years. Regulations prescribe the methods of logging so as to minimize injury of standing trees and of burning the litter to reduce fire hazard."

According to the Forest Service, California now cuts from her forests, which contain one fourth of the timber of the Pacific Coast, about two billion feet of timber per year. Lumbering ranks fourth among the industries of the state, and the annual value of lumber products amounts to $62,000,000, of which $9,700,000 comes from national forests. Even this huge cut does not care for the needs of California. With a population of 5,000,000 people, California uses more lumber than New York State with a population of 11,000,000. In fact, the three billion feet used annually to meet the needs of industry and development is the largest amount of timber consumed by any state in the Union. To supply this consumption the best stands of lowland timber are being cut and little attention is being paid to plans for replenishing the supply on privately owned lands. Fortunately, about sixty per cent of the forest area of the state has been reserved and to this supply the state will have to turn. Under proper administration it can be made to furnish a permanent supply without reducing the forest capital.

In 1926, California stood first among all states in hydro-electric development, and second in potential power resources. In many instances water of the streams is utilized several different times by erecting a chain of power houses. Most of this hydro-electric development has taken place

within national forests and under supervision of the Forest Service. Likewise, most of the irrigation projects, including large storage reservoirs, were necessarily developed within national forests.

There are many enemies of trees: insects, fungus, fire. The last named needs emphasis for the role played by fire in California forests is astounding. Men who have studied fire scars on pine trees have been able to show that there is a recurrence of fire years, indicating a periodicity of eight years. In Huntington's investigations on big trees (*Sequoia gigantea*), the fire history goes back as far as A. D. 245. Fire, therefore, is not a new enemy of forests. The disconcerting fact, however, is that fires have become increasingly numerous. It is the cumulative effect of an increasing number of fires that we need fear most. Scars of a single forest fire are negligible in comparison. With this in mind it is no wonder that the United States Forest Service has stressed protection against fire, even to the point of requiring a visitor to the forest during the danger period to refrain from smoking except at appointed camp grounds, and to carry a fire permit if a camp fire is to be built.

No government agency has been more active in educational work or more ready to utilize the most up-to-date methods of administration. Most forest officers are trained university men. They know their business; they plan and direct with ability. There is not a person who travels National Forest highways or trails who cannot from memory repeat the wording on various sign posts. Many a person has been admonished as to fire regulations through a slip of paper that drops from his laundry package, or by verbal remonstrance from his twelve-year-old who had learned his lesson at school. Investigate fire protection equipment in a national forest and you will find the latest in water pumps. The fire lookout contains every ingenious

device for the accurate locating of every fire discovered. The whirr of an airplane over a camp-ground in the Sierra occasions only the suggestion: "That's just one of those forest fire patrol planes." Not only are airplanes valuable in discovering and locating a forest fire, but they are particularly helpful in determining its extent and the best place for concentrating fire fighting forces. An observer in a plane can make, in an hour or two, a fire-reconnaissance that would take a man on foot or horseback days to accomplish, to say nothing of the difference in visibility owing to the smoke.

The objectives of fire protection that have often been pointed out are:

1. To prevent an injury to standing timber by fire.
2. To safeguard young growth already established within the older and cut-over land.
3. To promote natural reproduction so far as this can be done by fire protection measures.

Although originally set aside to provide a continuous supply of merchantable timber, national forests provide other crops which are likewise harvested. Grass and brush lands within national forests are rented as grazing lands. These same forests produce a crop of fish and game annually harvested by the angler and hunter.

Henry S. Graves, former Chief Forester of the United States, has splendidly pointed out the relations between the forest and animal life:

"Forests are more than trees. They are rather land areas on which are associated various forms of plant and animal life. The forester must deal with all. Wild life is as essentially and legitimately a part of his care as are water, wood and forage. Forest administration should be planned with a view to realizing all possible benefits from the land areas handled. It should take account of their indirect value for recreation and health as well as their

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value for the production of salable material; and of their value for the production of meat, hides and furs of all kinds as well as for the production of wood and the protection of water supplies.

"Unquestionably the working out of a program of wild life protection which will give due weight to all the interests affected is a delicate task. It is impossible to harmonize the difference between the economic, the asthetic, the sporting and the commercial view-point. Nevertheless, the practical difficulties are not so great as they appear on the surface.

"Wild life is largely a forest product. It should be regarded as a public resource, to be protected and systematically developed. It is a resource which is easily destroyed under abuse; but it readily responds to right treatment. The intelligent fostering of the valuable wild life of the forest is and has always been one of the objects of forestry."

In more recent years the recreational uses of national forests have come into prominence. These forests offer abundant opportunities for motoring, hiking, camping, picnicking and divers other forms of outing. Every forest in the state has its free camp grounds, oftentimes with conveniences all furnished. Hundreds of miles of trail and road make these forests accessible.

The newest development in the national forests is that of summer homes. Oftentimes developments include the surveying of lots and the building of roads and trails. Within ten years the few permits originally granted near Los Angeles and at Lake Tahoe increased to nearly four thousand. Big Bear Lake in the San Bernardino National Forest in 1927 had some 1,800 summer permittees and fifty resorts. The restrictions are few. Many a business man has gained healthful and keen enjoyment in clearing a small area and erecting thereon a cabin in accordance with

his purse and ability. There are no building restrictions except that improvements must be permanent, neat, attractive, and in keeping with the natural surroundings. Lots are from one quarter to one acre in size, and the rental varies from $10.00 to $25.00 per year. The lease is negotiable with the consent of the Forest Service. Thousands of urbanites spend every week-end during the summer at their mountain cabins, the sites of which are rented to them by the Federal government.

The increasing recreational use of the national forests is a thing to exult in, but it also brings dangers which need consideration. The appealing thing thus far about forests has been the virgin conditions encountered. More and more the visitor encounters just the things that he is attempting to get away from: roads, houses, noise and tin cans. Natural conditions are being modified so rapidly that complaint is general. We boost the national forests as playgrounds and the millions who precede us trample the ferns, pollute the streams, and often leave their garbage to disturb our nose and eye. Tin cans and rubbish-befouled camp grounds, smoldering fires which result in blackened hillsides, are all too common monuments to the American tourist's discourtesy. The "tin-can tourist" is becoming a disgrace to our outdoors. Altogether too many forget that others desire a green forest for shade, a clean grassy spot for a camp ground and pure stream water to drink. Even education along the lines of "keep your camp clean" will not satisfactorily handle this disturbing situation.

In view of the recognized contribution of the wilderness to American culture and the growing demand for restricted use of some areas reminiscent of our pioneer environment, the Forest Service has recently determined upon a policy of non-commercial development of picked sections. Wilderness areas are left as they are, to provide

the enjoyment that comes with primitive travel, primitive subsistence and primitive outdoor recreation. The move has come none too soon. Of seven large areas in California ten years ago, only two are left unmotorized. The auto camper is being given a widening field for exploration; the man with a pack train or knapsack is fast losing the recreational lands of his choice. The latter has as much right to demand a freedom from auto roads as the motor tourist has right to demand them. Proper balance requires both. Economic use should be made of some areas and others should be free of such spoliation as that described by Badger Clark in his splendid poem, "God's Reserves":

"Then the White Man came, as the East growed old,
And blazed his trail with the wreck of war.
He riled the rivers to hunt for gold
And found the stuff he was lookin' for;
Then he trampled the Injun trails to ruts
And gashed through the hills with railroad cuts.

"He flung out his barb-wire fences wide
And plowed up the ground where the grass was high.
He stripped off the trees from the mountain side,
And ground out his ore where the streams run by,
Till last came the cities, with smoke and roar,
And the White Man was feelin' at home once more."

Man will always wish to turn from the turmoil of cities to the tranquillity of the wilderness. With thought for the future, this will be possible. With present-day tendency to develop everything, such alluring areas are doomed.

The forest brings to us no end of blessings. The prime necessities of life—food, water, shelter, clothing and fuel—all are dependent in one way or another on forests. Yet dependent as man is on forests he has not always shown due appreciation of them. Too often forest wealth

is destroyed without making provision for replacement. Destruction by ax and flame continues without abatement. However, the uses of the forest are being made known and a new generation, it is hoped, will profit by the mistakes of a past one. Forests must be treated in such a way that they will be able to renew themselves and thus perpetuate this most important resource. Though an easy defense of the setting aside of scenic parks and forest reservations can be based on sentiment and esthetic considerations, yet it has been found that such action pays. It pays in beauty and in health; and by their continued power to attract visitors, such areas keep on paying "long after the original expenditure has been forgotten."

Chapter X

CHAPTER X

Recreation

A reasonable amount of leisure and a good use of it is an important contribution to a happy life.

—Viscount Grey of Fallodon.

THERE ARE many factors contributing to the making of a happy life and most of us will agree with Viscount Grey that good use of a reasonable amount of leisure is an important one. Most of us could make good use of our leisure but our difficulty arises in finding that "reasonable amount." Our Englishman can and does find leisure so necessary to a calm, reposeful life—but we Americans! Perhaps we can find it, but as a rule we do not.

John Muir in his pleasing fashion has written classic paragraphs on the necessity of wildness. (*Our National Parks*, pp. 3-4.) Lest there be some wilderness lover who has chanced not to read it, it is quoted here:

"The tendency nowadays to wander in wildernesses is delightful to see. Thousands of tired, nerve-shaken, over-civilized people are beginning to find out that going to the mountains is going home; that wildness is a necessity; and that mountain parks and reservations are useful not only as fountains of timber and irrigating rivers, but

as fountains of life. Awakening from the stupefying effects of the vice of over industry and the deadly apathy of luxury, they are trying as best they can to mix and enrich their own little ongoings with those of Nature, and to get rid of rust and disease. Briskly venturing and roaming, some are washing off sins and cobweb cares of the devil's spinning in all-day storms on mountains; sauntering in rosiny pinewoods or in gentian meadows, brushing through chaparral, bending down and parting sweet flowery sprays; tracing rivers to their sources, getting in touch with the nerves of Mother Earth; jumping from rock to rock, feeling the life of them, learning the songs of them, panting in whole-souled exercise, and rejoicing in deep, long-drawn breaths of pure wildness. This is fine and natural and full of promise. So also is the growing interest in the care and preservation of forests and wild places in general, and in the half wild parks and gardens of towns. Even the scenery habit in its most artificial forms, mixed with spectacles, silliness, and kodaks; its devotees arrayed more gorgeously than scarlet tanagers, frightening the wild game with red umbrellas; even this is encouraging, and may well be regarded as a hopeful sign of the times.

"All the western mountains are still rich in wildness, and by means of good roads are being brought nearer civilization every year. To the sane and free it will hardly seem necessary to cross the continent in search of wild beauty, however easy the way, for they find it in abundance wherever they chance to be. Like Thoreau they see forests in orchards and patches of huckleberry brush, and oceans in ponds and drops of dew. Few in these hot, dim, strenuous times are quite sane or free; choked with care like clocks full of dust, laboriously doing so much good and making so much money, or so little, they are no longer good for themselves."

California, blest with snowy, forested mountains, fruitful valleys, colorful deserts and rugged or sandy shore lines, gives the seeker of beauty or happiness the widest possible opportunities, a choice from the driest, hot desert to the coldest of snow-covered peaks, with some of the world's finest forests and mountain streams in between; with every gradation of rolling hill and mountain meadow, of sunny plain and shadowed grove. These form a wide gamut from which to choose, and accessible to all who desire. Even the peaks of highest altitude are not forbidding to those who know the mountains.

Mountaineering

Conditions favor those who seek the highest points for the view. Even in scaling the highest peaks one has to spend but a few hours in snow and then it is seldom dangerous. The Swiss Alpine climber must have his guide, his alpine stock, and his rope; he must realize his danger and watch for crevasses and avalanches. In the Sierra one camps at timber line, rises early and makes the ascent and back to camp before dark. What few accidents there are result from an unstable rock or from foolhardy climbing. Some mountain climbers fail to remember the glare of the snow and, not taking precaution, suffer from snow blindness.

Splendid government contour maps may be had for nearly any area. One who knows how to read one of these maps is in no danger of getting lost. Those who prefer company may join a mountaineering club and thus find kindred spirits with whom to reach the summits.

Because of soft snow and unfavorable weather conditions, Sierran peaks are seldom attempted in winter. Mt. Whitney has enticed several parties to make a try but each has found it necessary to turn back between the

10,000 and 11,000 foot level. The Sierra Club Bulletin has chronicled most of the attempts made thus far.

Probably no two people receive the same benediction from the same trip to the mountains. The inspirations themselves are innumerable: the clouds, the sunrise, a jagged peak against the sky, a trail through a quaking aspen grove, a thunderstorm, a snowy, wind-swept mountain pass, a rugged pine, a rushing torrent, or the murmur of a high mountain meadow stream; the soaring of an eagle, a dogwood tree in bloom, the song of the hermit thrush, a granite dome, a lichen-covered rock in a bed of magenta-colored mimulus; the flash and poise of a humming bird, the doe and her fawn in the early evening, a lovely lady's-slipper in her cool abiding place, or perhaps, the all-pervading quiet of a mountain night.

These, then, with their kindred hosts, cannot fall with equal appreciation on each of the countless moods and temperaments of those who encounter them. And so might it be with the individual; one's state of mind changes so often that two trips to the same place would not necessarily leave the same impressions. Most likely they would be entirely different.

It has been my pleasurable lot to spend eight summers in the same part of the Sierra. Many friends have condoled with me and asked if I did not become tired of the same place, year after year. But I could truthfully answer them this last season that it was the finest summer of them all; that each year has always been better than the one before.

The mountains call us; some for their easing quietude, some for their very boldness (as does the sea to others). And we answer the call according to our desires. To some adventurers it is just the spirit of the mountains that calls, to some it is the lure of the trail.

There are two widely different attitudes (or methods)

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expressed in taking a trail. One may "hike it," striking out with speedy stride, dashing up to the summit of a popular peak, stopping just long enough to pull out a watch to see the exact time, then, with one sweeping glance around, start the downward journey on the gallop, making all the little woodland creatures scurry to cover as one passes, but arriving at the starting point in plenty of time to brag about "beating so-and-so's record to the top by sixteen minutes."

One may "hike it," or one may saunter. A. W. Palmer in *The Mountain Trail and Its Message* gives a deep meaning to the word saunter:

"Do you know the origin of that word saunter? It is a beautiful word. Away back in the Middle Ages people used to go on pilgrimages to the Holy Land and when people in the villages through which they passed asked where they were going, they would reply: '*A la sainte terre*,' to the Holy Land. And so they became known as sainte-terre-ers, or saunterers. Now these mountains are our Holy Land, and we ought to saunter through them reverently, not 'hike through them.' And John Muir lived up to his doctrine. He was usually the last man to reach camp. He never hurried. He stopped to get acquainted with individual trees along the way; he would hail people passing by and make them get down on hands and knees, if necessary, to examine some tiny seedling or to see the beauty of some little bed of almost microscopic flowers."

Note the thrill of accomplishment indicated in this quotation from Clarence King, pioneer mountain climber of the Sierra:

"In long Sierra journeys the mountaineer looks forward eagerly, gladly, until pass or ridge-crest is gained, and then, turning with a fonder interest, surveys the scene of his march; letting the eye wander over each crag and valley, every blue hollow of pine-land, or sunlit gem of alpine

meadow. . . With a lingering look he starts forward, and the closing pass-gate with its granite walls shuts away the retrospect, yet the delightful picture forever hangs on the gallery wall of his memory."—*Mountaineering in the Sierra Nevada.*

There are those who go to the mountains to study, to learn more of the ways of Nature and try to delve into her past and wrest from her her long-standing secrets, to study the lives of trees, to learn the songs of birds and the habits of animals, or to acquaint themselves with myriads of wild flowers. Be he nature-lover, scientist, preacher or teacher, he will surely find more than he anticipated and be able to satisfy his craving for nature lore.

Needless to say, we are not all "hikers" nor all saunterers. There are some thousands of gradations between, but each individual leans either to one side or the other, some more, some less. One Sierra Club member climbed twenty-one peaks ranging between 12,517 to 13,960 feet in altitude in the southern Sierra one summer. A saunterer would have taken several summers to accomplish the same number of miles. His joy would come in the interest of his surroundings, not in the physical accomplishment of a peak.

To others the call of the mountains comes directly from their fish-laden streams, urging one to roam the byways with rod and reel always with the hope that there is "better fishing ahead." Here, too, is a wide variety of attitudes. Many go to the mountains to fish because the best fish are in mountain streams; others fish in the streams of the mountains, not so much for the fish as for the peace of mind and contentment that accompany the sport of fishing.

Hunting calls many a man from his office to the hills and mountains as the seasons open, and to the marsh land if he be interested in wild fowl. To some few of these,

their bag must be full to make them feel content; to the main mass of real sportsmen "the tramp with gun and dog, game bag empty or full, is time well spent."

One need not be worried as to "where to go" for a vacation in California; more likely there is the difficulty of elimination. With four national parks within its boundaries, several national monuments and five state parks (with hopes of more in the near future), all created for the enjoyment of the people, and eighteen national forests, created for forest conservation primarily but now having a human use in "forest recreation"—how could one go astray? A coastline wooded to the water's edge, rugged and rocky cliffs, long, low-lying beaches or palisaded bluffs, give an entirely different type of choice; add to these the two deserts and their surroundings and one becomes almost befuddled weighing their favors one against the other. How can one short span of life encompass even this small section of the globe! What shall we do about the other ninety-nine one-hundredths of the earth's surface? Perhaps it was a feeling akin to this unfulfillment or incompletion that inspired the ancients to believe in reincarnation.

Modes of travel in going to the mountains are many. By far the most popular method is motoring. It is the quickest way and the easiest way, and for many families the only possible way. Even in motoring there are two distinct ways of traveling: "motoring" and "gypsying."

"Motoring" is characterized by the least possible amount of luggage, probably two suit cases on a running board and a small trunk on the rear rack, the "motorists" taking meals at roadhouses and stopping at hotels or mountain inns at night.

Modern "gypsying" is a new art. Gypsying, from all indications, is characterized by the largest amount of luggage that may be carried with safety, also by the

greatest assortment of equipment. "Gypsying" means traveling in rough clothes with one's sense of humor uppermost and one's dignity left at home. Modern gypsies may pitch their own camp each night or make use of the hundreds of "auto" camps which spring up wheresoever a highway may lead. These auto camps are sometimes very simple and free of any charge. At some places, with more conveniences, a small charge is asked. Almost every town or city has its "municipal camp" in an outlying district.

It is at these camps that fun reigns supreme and a camaraderie exists which would be impossible in a hotel lobby. Even the most serious-minded develop a sense of humor and become surprisingly human and friendly. And let us not be mistaken in thinking that only Fords and Chevrolets are in the "gypsying" class. Packards and Cadillacs make a constant caravan to these selfsame camps and the owners of each mix with the greatest ease and neighborliness. Here, probably, are the most democratic spots in our land, and through their influence, as time goes on, castes will be broken and the separate layers of society will merge in a sympathetic understanding of each other.

I agree with Perry Evans that: "Any transportation is acceptable, even though tainted with gasoline odor, if it will get him to the charmed region more quickly. And for once he appreciates the speed of the automobile as it steadily clicks off mile after mile."

Another mode of travel much less popular, but capable of transporting one farther and deeper into the wilds, is the pack train. Of course one cannot make two and three hundred miles a day, but four feet may tread where four wheels dare not roll. Not being able to carry all of the luxuries, but most certainly all of the necessities, the pack train has unlimited pleasures and possibilities. The party itself may ride horses, or may walk, using all of

the animals for packing, depending, of course, on the individuals.

In my own experience, during a two-hundred-mile trip down the backbone of the Sierra, the six adults of our party walked the complete distance, the four horses being used entirely for packing with the exception of one, who, for his cautious ways and friendly manner, was honored with carrying the fifteen-months'-old baby in one of his "kyacks" and a three-year-old boy on top of his pack, as weary little feet demanded it. If one may eat well and sleep well with the necessities provided by a pack train when far out from the haunts of men, what more can one desire? The comfortable companionship of the horses alone repays one for any inconvenience they may cause.

A pack trip may be taken with varying degrees of comfort. Large pack trains with guides, packers, and cooks are often engaged where cost is no hindrance, and stoves and even cots and mattresses are part of the equipment. However, such an elaborate pack train is not necessary to establish a comfortable camp. For the average camper going into the back country, the care of a few pack animals and the packing itself are but added interests to the whole, as may be the cooking also. The deeper, fuller appreciation and joys of a back country trip are greater for those who throw their own hitch and flip their own pancakes than for those who sit on the side lines and watch the intricacies of the "diamond," and the still more intricate proceeding of making a "Back Country Mulligan." Ask those who have had experience!

Is anything more inviting after a day's roughing it in the mountains than a comfortable sleeping bag resting on springy, resinous pine or fir boughs? A few minutes spent in preparing a resting place for the sleeping bag insures the night's rest against the perplexing bumps and angles that mean hours of restlessness.

Burros are often used in the mountains for packing instead of horses, not often in large pack trains, but when only two or three animals are needed, as for the use of a family. Burros are so much shorter and smaller than horses that they are much easier to pack, and the feeding problem is simpler than with the larger animals. However, they are much slower than a horse and need constant urging to make them keep up to the pace of an ordinary hiker. And when a stream is to be crossed! Then the burro becomes a stubborn unreasoning demon and his owner a cursing madman. Notwithstanding this occasional departure from good behavior, the burro is still the favorite companion of many a mountaineer and hiker. And who can picture a prospector without one! The burro's sure-footedness and dependability at all other times console one for the times he has to be beaten or snubbed across each stream of water.

The mule is used extensively in packing, especially in supply pack trains, for his strength and sure-footedness are unequaled. He is also used much in the mountains as a mount because of these same qualities.

Still another mode of travel is the use of "that most ancient vehicle of all, the human foot." This of course includes hikers, trampers, saunterers, knapsackers and—I was about to say those latest style, up-to-the-minute tramps who stand in the highways and byways beckoning the driver of any automobile likely to give them a lift; but they do not belong in this class for they must be riding to be satisfied.

Knapsacking is the most independent method of traveling in the mountains. There is neither fear of running out of gasoline, nor worry about finding good "feed" for the pack animals when making camp for the night. Also, a knapsacker may negotiate trails, and many trailless stretches, where no horse or even burro could possibly

follow. He may change plans suddenly without having to consider others. But for this independence he pays in having to carry his own pack. The size of the pack depends chiefly on the length of the trip. Knapsackers usually carry in the neighborhood of forty pounds at the start for a trip of any length. Some men have carried as much as sixty pounds, but it isn't popular; and many carry as little as twenty-seven pounds for a two weeks' trip, having a variety of edibles at that. The old-fashioned knapsack has given place to the ruck-sack or the harness which better distributes weight. Desiccated milk, eggs and vegetables are modern aids to a light pack in which the knapsacker delights. Seldom is there one wise enough to resort to that staple of the western pioneer who searched out the new land—parched corn-meal known as pinole. It is doubtful whether other foods contain so much stored energy per pound weight, and so adequately satisfy hunger.

Maximum comfort with minimum weight is the objective of every knapsacker. If essentials are omitted discomfort and even hardship may result. The extremist on the one hand gets along with one dish, one kind of food and a pocket knife. On the other hand there are those who burden themselves with canned goods and numerous extras seldom used. With care a one- or two-man equipment, exclusive of food, can be reduced to ten pounds, this to include shelter, warm clothing, sleeping bag and toilet articles. Minimum food supply must be reckoned at 2½ pounds per day. With each additional member of the party the weight per individual can be somewhat reduced.

Alluring Recreation

There are many to whom the sea calls—the vastness of it and the vagaries of its various moods. In its utter

restlessness they seem to find peace. Not all may have the privilege of a sea voyage but in these motorized days almost everyone may enjoy the seashore at one time or another. Beach life has its splendid facilities for recreation, with its chances for boating, swimming and fishing. Too often, however, these sports are entered into in such a desultory manner that they lose their power as regenerators. But even lying on the beach in a pretty bathing suit (present style) has its advantages! The violet rays of the sun have a chance to do their work.

The increase in tent cities and in the number of beach towns in recent years is certain evidence of the lure of the sea. And as these towns grow, so do they sooner or later erect municipal piers which simplify surf fishing and give opportunities for fishing to hundreds who otherwise would not fish at all; for the number who go out in small boats to fish, or who fish from anchored rafts, is small compared to those who fish from the piers or rocks on shore.

California's long line of seacoast gives ample opportunities for swimming to those so inclined. Added to this is the ever increasing number of plunges, either salt water or fresh, which are important features of every beach town. Inland towns are also finding the necessity of municipal plunges, and no new club building is complete without its swimming tank.

Swimming, the exercise which leaves no muscle inactive, has come into its own. It is being taught in the schools; it is a prerequisite in most of the character-building organizations, and long distance swims have taken their place in the front ranks of athletic contests. Annually there is the contest swim across the Golden Gate and now, added to this is the channel swim from Catalina Island to the mainland, a distance of more than twenty miles. In the southern part of the state the surf is used

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continually, all through the winter, by devotees of the salt water. In San Francisco the Olympic Club even features a New Year's Day swim in the ocean.

The desert, too, has its attraction, and to those who have once become interested in it, there is no escape; they are bound to its lure forever. Albeit there is an elemental struggle for existence waging unceasingly day by day on the desert, one does not see it on the face of things, but enjoys the "sublimity of its lonely desolation." Particularly has the desert a call for those interested in wild life, either plant or animal, for the desert forms the finest exhibit of special adaptation between plant and animal life and their environment. Time after time will the lover of nature be called back to the overwhelming silence of the desert. The California deserts, Mojave and Colorado, boast winter resorts which are made attainable these days by the universal use of automobiles.

Clubs Promoting Recreation

Foremost among California's recreational clubs is the Sierra Club, founded in 1892 by a number of persons who, appreciating the beauty and grandeur of our mountains, joined in an effort for their preservation. Its first president was John Muir who continued in that office for twenty-two years until his death in 1914.

The purpose of the club, contained in its own constitution, is: "To explore, enjoy and render accessible the mountain regions of the Pacific Coast; to publish authentic information concerning them; to enlist the support and cooperation of the people and the government in preserving the forests and other natural features of the Sierra Nevada Mountains." A noble purpose, to which the club has conscientiously adhered from its beginning!

Besides the club's interest in national parks, in directing public attention to the beauties of the mountains of

the Pacific Coast, in trail building and in exploration, interest centers in the annual outing in the mountains for members and their friends. This outing is unique in method of handling a group of people in the more remote regions of the mountains at a minimum expense and under most comfortable circumstances. Each hiker is allowed a duffle bag, which, when filled with his belongings, cannot exceed certain prescribed dimensions. These are packed on mules, as are also the stoves and food supplies.

Usually one or more base camps are established and short or long hikes are taken from them. Always an important event in the life of the camp is the evening campfire. Here, under millions of stars which cannot be seen through the smoky atmosphere of a city, and amid the eternal bigness of the mountains, members gather to commune with one another. Discussion of the trip for the following day is always part of the program. Chorus singing of familiar songs is one of the joys never to be forgotten; often individual or group stunts are given for the entertainment of the others.

The love of the mountains felt by every member of the Sierra Club is shown by their appreciation of John Muir and his writings. Printed on their folio is a quotation from him which reads: "Climb the mountains and get their good tidings. Nature's peace will flow into you as sunshine flows into trees. The winds will blow their own freshness into you and the showers their energy while cares will drop off like autumn leaves."

The California Alpine Club was organized in San Francisco in 1913 with its object comparable to that of the Sierra Club. Like the Sierra Club, the California Alpine Club makes much of its summer trips into the high mountains. Plans are commenced the year before the outing,

so that by the time summer has arrived every detail is complete and there is no time lost in getting a start.

Conservation clubs are often the outgrowth of hiking clubs, turning some of their energies toward protection of certain specified areas, such as the Tamalpais Conservation Club. Though still composed chiefly of hikers this club has undertaken the protection of Mount Tamalpais. Receptacles for refuse have been placed on the mountain, trails made and fire breaks slashed and many other projects started by this energetic group. Fortunate the vicinity to have such a club as its guardian!

However, one does not have to belong to a hiking club to enjoy this land of beauty. To watch the Marin County ferries leaving San Francisco, or to stand in the Pacific Electric terminal in Los Angeles Saturday afternoons and Sundays proves without a doubt the lure of the hills for the city dweller. And we know that these countless thousands do not all belong to hiking clubs; probably a very small per cent carry their names on any club roll. W. L. Jepson calls attention to this fact: "Travelers from the East constantly comment upon a California phenomenon never seen in eastern cities—the long lines of men and girls pouring out of our cities and towns on holidays clad in hiking costume, filing along the roadways, for the roads lead to the trails and the trails to the hills."

Throughout the state there are organizations developing nature walks. With a competent leader these walks are a source of great interest and education, the participants becoming familiar with the bird, animal and plant life around them. The Audubon Societies feature their nature walks, as does the Nature Club of Southern California.

The nature trips of the San Diego Museum of Natural History have developed so rapidly that they are now attended by hundreds of people. The Extension Division

of the University of California offers courses of study including trips afield.

This is an age of organization. How pertinent then that such a large number of our organizations, especially those concerned with young people, tend to draw their members out-of-doors. It is a disconcerting fact to those pessimistically inclined individuals who insist that the present generation falls far short of its forebears in physical fitness and endurance, for even they must concede that outdoor activity can not be equaled for its strength-developing qualities.

"Out-of-door recreation is accepted as a necessary part of the life of a Californian—as a vital element in bodily well-being, mental diversion and imaginative stimulus," says Willis Linn Jepson of the University of California.

Young Men's Christian Associations, Boy Scouts, Camp-Fire Girls and other character-building organizations for boys and girls lay great importance on their outdoor activities and there are few such organizations that do not have a summer camp as a special feature of their year's program. Under competent guidance and supervision many children who otherwise would not have any change of scenery, enjoy vacations at these camps, for the cost is made as reasonable as is practically possible. Here they may have their outdoor sports and outdoor instruction amid associations and surroundings that will furnish them a background for years to come.

In the last ten years municipal camps have been established throughout the state, some communities supporting at least three camps in different locations. These, again, are conducted on such an economical basis that any citizen may enjoy a week or more in the mountains at a reasonable cost. Recreation parks are scattered through our cities, owned by the schools or the munici-

pality, giving boys and girls a safe place out-of-doors in which to play, always under expert supervision.

Summer resorts came into being decades ago. Tent cities on the beaches and cabin resorts in the mountains grew in pace with the ever increasing population of the state and kept on growing until now this western land is a "paradise" of resorts. Not only the mountains and beaches have their miniature cities but even the deserts boast their resorts. The evening community camp fires form an attractive part of the day's program at most of these places.

As facilities for transportation increase, winter sports are becoming much more popular in California and winter resorts are springing up in various places. Truckee was the first place to attain distinction as a winter resort. With its new all-year road open, Yosemite is now a favorite for winter sports, including sleighing, skiing, tobogganing and ice skating.

Dude ranching, originated by accident with Howard Eaton in the Dakotas, has now spread to California. It has filled the need for those who want to live simply and to some extent primitively in a far-western sort of way. A dude ranch is a ranch first of all—not a hotel or club. The duty of the dude wrangler is to "explain the far west to the Easterner and to preserve what is useful and beautiful of the far west for future generations."

Country club life in California is increasing yearly as busy people in the cities realize that they cannot stand the hurry, scurry and strife of modern business without an occasional rest. And to have rest they must seek it outside of the city gates, away from the skyscrapers and elevators; away from the telephone and engagement pad; out where a breadth of view is obtainable and where soft earth may be felt under foot. Ellen Burns Sherman avers that:

"The more civilized man becomes the more he needs and craves a great background of forest wildness to which he may return like a contrite prodigal from the husks of an artificial life."

The usual accompaniment of a country club is a golf links. This means stretches of open, stretches of green grass. Here the tired business man finds rejuvenation. Municipal country clubs and golf links are numerous and make this type of recreation available to many who would be barred from expensive private clubs.

Vacation recreation comes to most of us but once a year. At that time we put forth all our energies toward having a good time, usually receiving all physical benefits after vacation is over. But in this day we have opportunities for recreation on every side, not only for summer vacations and week-ends, but for every day in the year. Schools have a variety of recreation to offer that cannot help but please every child. Organizations carry on the same plan, both for those who have no other opportunity and for those who already receive benefits in school. And more and more, city governments are looking to the recreational needs of their citizens, for their adult population as well as their youth. So, whether it be in the mountains in the summer-time or in regular daily diversion close at home, may our recreation not only bring us

pleasure but physical strength, mental alertness
and spiritual refreshment; for with these
come an added zest of living, which
contributes to the genuine
happiness we all seek.

Chapter XI

CHAPTER XI

The Four Horsemen

With the coming of civilization, the grasses and the wild flowers perish, the forest falls and its place is taken by brambles, the mountains are blasted in the search for minerals, the plains are broken by the plow and the soil is gradually washed into the rivers. Last of all when the forests have gone the rains cease falling, the streams dry up, the ground parches and yields no life, and the artificial desert—the desert made by the tramp of human feet—begins to show itself.

—John C. Van Dyke.

THE FOUR Horsemen of the Apocalypse, so vividly described by Ibanez, do not confine their depredations to humankind, nor did the war succeed in sweeping them from our midst. War, Famine, Pestilence, and Death take a continuous toll of the natural resources of this and every state. In explaining the diminution of forests, of fish and game and other natural resources, I shall recount the devastation wrought in recent years as being the work of these four horsemen.

It takes an army to make war. The attacking army concerned in the case of game is made up of two hundred and fifty thousand hunters, judging by the hunting licenses annually issued in the state. Statistics available since a deer license law was enacted show that approximately seventy-five thousand men hunt deer. The proportion interested in water-fowl is problematical.

Just these few figures are enough to show that the army is a large one.

This army is wonderfully equipped. It has the most modern guns and ammunition. The wildfowler carries an automatic shot gun that fires five shots in as many seconds; the deer hunter carries a rifle that shoots accurately, and the steel-jacketed bullet will carry a mile. Furthermore, the army is mobilized; its reconnoitering is easily accomplished at a great distance from its base; a few hours puts a company on the firing line and routs the enemy from its most secret hiding places.

Though gas is not used extensively, resort is made to poison campaigns. This is particularly noticeable in connection with predatory animals. Poison is spread broadcast and both friend and foe fall. The increasing scarcity of fur-bearing mammals can be attributed at least in part to these extensive poison campaigns. In the attempt to control rodents which destroy the farmers' crops, resort has recently been made to a dangerous mineral poison, which kills slowly, so slowly, in fact, that there is danger that game birds which have eaten some of this poison might well be instrumental in causing the slow death of the hunter who uses them for food.

Much can be said for the modern method of hunting when a single bird is marked, for there were days when it was not a matter of sport but one of slaughter backed by the incentive of dollars. In those days it was not a matter of one bird at a time but of a dozen or more to a shot. During the height of the market demand for ducks the market hunter devised some effective means of getting game in quantity. A trained bull or steer was used as a blind. The hunter "walked the shot," driving his animal slowly around a flock of feeding birds. Stepping from behind his animal, on close approach, he fired two shots from a large bore gun (No. 4-gauge), one barrel as

the birds were feeding and the other as they rose in flight. Sometimes a four-barrel gun was used. Wagon loads of ducks and geese were thus obtained. There are recorded instances when as high as 184 ducks were retrieved from the use of this method of hunting, termed "bull hunting." Such activities by the horseman War have been restricted, but the automatic with enlarged capacity is now the weapon of destruction used by the violator, who "ground sluices" his birds.

The casualty list is great. A census of the deer killed for the season 1928 showed a total of approximately 21,500 deer taken by hunters. The number of ducks killed annually in California is estimated at a million. There are no data to show what the toll of upland game birds, such as quail, may be. The angler's catch of trout must total close to a million. So long as the casualty list is not too great, war continues without imperiling either side, but when the total becomes too great, danger is imminent. Whether our resources in wild life can withstand such a drain seems doubtful.

There are righteous wars and unrighteous wars. I would not for an instant have my readers believe that I would wipe out entirely the warfare just described; I believe that it is perfectly proper to utilize fish and game resources. Game birds, animals and fish furnish food and recreation and it is proper that this use should be made of them. My main point is that this horseman War is responsible for a casualty list so large that one of the contending armies cannot survive and is likely to be wiped out of existence, with small possibility of rehabilitation.

I have never visited a famine-stricken country such as China or India, but I have visited places where the horseman Famine had been a scourge in the land. I visited Lower Klamath Lake in the summer of 1914,

when it was in its prime as a federal bird reservation. On the lake I saw many Canada geese with their broods of young. I found the shores lined with killdeer, avocets, and other shore birds. On visiting bird islands I saw a concentration of water birds the like of which I do not expect to see again. Nests of pelicans and cormorants were separated by the length of the necks of the two birds, a distance sufficient only to prevent fighting. I visited the same region in the summer of 1925. Conditions were quite different. The only water was a sheet of brown alkali water but a few inches in depth. Marsh vegetation had disappeared. Fires had burned deep holes and the ashes had been blown across country. Water birds had disappeared. Bleak, white alkali met the eye in every direction. Here indeed was Famine, so far as waterfowl were concerned. Why had Famine stalked through the land? Because some land promoters, believing that they could make some money, succeeded in drawing the government into a drainage program which furnished but a small piece of land fit for agriculture at the northern end of the lake and a great territory of worthless land on the old lake bottom. Meantime, there had been destroyed the largest and finest of western federal game reservations.

The lake bottom has been pastured by sheep, and landowners use this as a justification for the unfortunate drainage project. Such adherents fail to remember that sheep can be reared most satisfactorily on cultivated ground. Alfalfa fields and stubble furnish the best of food. On the other hand, wildfowl can not be reared satisfactorily on similar lands. Large bodies of water are necessary for breeding grounds and for safety. As a consequence, good agricultural lands are the logical location for sheep breeders, whereas lakes and marshes should be allotted for breeding of wildfowl. The sheep industry holds its own, whereas our resources in wild-

fowl have been greatly on the decline. Unless more careful allotment of lands in relation to wild-fowl is made, we shall lose entirely the benefits which accrue from this resource, and replace it with some standardized live-stock industry. In the case of Lower Klamath Lake, if it is a matter of weeds or wild-fowl, can there be any doubt that more people are definitely interested in the saving of wild-fowl than in the production of weeds for sheep?

As a biologist might have prophesied, the resultant disturbance of the balance of nature at Lower Klamath Lake showed itself in a vivid way. Grasshoppers, which had doubtless been held in check by the numerous water birds nesting in the vicinity, gradually increased in numbers until they became a plague. Thousands of dollars were spent in 1921 in attempting to control them, and similar amounts the following year, with practically a total loss of the crops. Only a resort to flame-throwers such as were used in the World War finally aided in correcting the situation. Eliminate natural checks on insects and there results a plague.

This picture of a famine-stricken area within our own state is but a sample of what the horseman Famine has accomplished through the years. There once existed a great marsh from Buena Vista Lake on the south to Los Baños in the great central valley. Buena Vista Lake is now dry. Tulare Lake, once one of the large lakes of the state, has been drained and the whole lake bottom is now cultivated land; not even a sump remains. The intervening marshes have likewise been drained and water-fowl are forced elsewhere to find suitable feeding and breeding grounds.

Upland game birds have been similarly treated. The great stretches of brush land in Southern California which formerly harbored countless thousands of valley quail are now replaced by orange groves and deciduous fruit

orchards where there is little ground cover or food supply left for quail.

We cannot eat our cake and have it, too. We cannot utilize our forests for the rearing of cattle and sheep and expect native wild life to hold its own. The best statement we have seen on this subject is the following from Joseph Grinnell, Director of the California Museum of Vertebrate Zoology:

"No amount of game laws, the perfect control of hunting and fishing, will bring an improvement in output of wild animal life *unless* there be provision of adequate food and shelter for it. If the food be appropriated by live stock, and the natural cover be destroyed by browsing or trampling by live stock, the output of wild life will inevitably continue small; not only that, but it will shrink down even to the vanishing point in the case of many sensitive species. We will then have lost, beyond retrieving, many animals of positive use in the maintenance of the healthy life of forest trees, many animals of marked esthetic and recreational value, and many animals of direct commercial value."

Famine threatens fish. In many instances, whole streams are diverted from their beds, passed through a tunnel and into an entirely different watershed. Such diversions mean famine conditions for fish. Originally, hydro-electric power development took place in the higher mountains. The amount of feeding and breeding grounds for migratory fish cut off by the high power dams was negligible. Plans for the future include the building of two-hundred-foot dams near the mouths of some of the larger streams notable for their runs of salmon and sea-going trout. Such obstructions will effectually block fish from their normal feeding and breeding grounds. The horseman Famine continues to take his toll in the land.

In like manner the horseman Pestilence has been active.

Within the past few years it was found necessary to destroy twenty thousand deer in the Stanislaus National Forest in order to control a serious disease brought into the state through man's agency. The hoof and mouth disease spread from domestic cattle to the deer, and had it not been controlled by the sacrifice indicated, this dangerous disease might have swept the whole country. In 1912, large numbers of deer died in Trinity County. Investigation showed a bladder worm infestation. Where these parasites had their origin it was not possible to find out. But here the horseman Pestilence had been at work.

A government estimate of the number of ducks which have died from a strange malady known as "alkali poisoning," which seems to be an accompaniment of drainage projects, is set at fifteen million in the past fifteen years. The disease has not only been serious on the Bear River marshes of Great Salt Lake, Utah, but also in several locations in California. When Tulare Lake was dried up, hundreds of thousands of ducks and other water birds died from this disease. More recent outbreaks have occurred at Tule Lake in the extreme northeastern corner of the state.

A few years ago I was invited to investigate conditions on a beautiful mountain stream in Santa Cruz County. In traversing less than a mile of this stream, sixty-five fine large steelhead trout were found dead along its banks. Some of these fish weighed six to ten pounds and when females were opened, they were found full of eggs, two thousand or more, fully ripe and ready to be deposited. The banks of this stream were black with oil and the water had a milky-white appearance. The cause was to be found in the fact that a nearby city turned its sewage into this beautiful stream. Not only did the waste oil from garages find its way into the sewer, but also the refuse

chemicals from spray factories. These steelhead trout, returning to their parent stream used as a spawning ground through the ages, had found life impossible in this pollution.

Due to the development of the oil industry in this state, the greatest problem is connected with oil pollution. The oil is piped from the oil fields to our harbors, where it is stored, refined and loaded on ships for fuel and transportation. Formerly ships came into the harbors and after unloading their cargoes, and before taking on a new supply of fuel oil, pumped the bilge water into the bay. Thus was oil spread on the water. Conditions, fortunately, are improving. Even now oil frequently gets away through accident or carelessness and causes great damage to harbors, to bathing beaches, pleasure boats and other water craft. The piling around the various piers becomes covered with oil which adds greatly to the fire hazards.

Of equal concern are the damage and destruction to bird and fish life. The feathers of the various kinds of water birds become saturated with oil so that they cannot fly and sooner or later die. The loss of water birds, such as wild ducks, from this cause is at times very serious. Young clams on the beaches and mud flats are killed by waste oil. Fish are damaged indirectly by lack of food, caused by the oil's killing the diatoms and other plankton which form the basis of the food supply.

Thus does the horseman Pestilence continue to take from us our wild life resources.

The fourth horseman—Death: extinction—is most to be feared. The grim reaper has met but little opposition. He already has to his credit two valuable game birds and two valuable game mammals and he is reaching out to slay a score more. The grizzly bear, the animal for which our state is sometimes named, and a picture of which is to be found emblazoned on the Great Seal of this state,

is now extinct. Not more than two or three have been killed within the past twenty years. Let the cattleman say that it is good riddance, but I regret that I am unable to take my boy into the mountains and at least show him the footprints of that monarch of the forest, which enters so much into the early history of California.

The grizzly bear was not the first large animal claimed by extinction. About 1810 a group of Russian fur traders from Ross, Marin County, went out to the Farallone Islands and there took thousands of Guadaloupe fur seals in two years. They exterminated the herd of fur seals frequenting these islands and the state lost a valuable resource.

Recent research has shown that the buffalo once ranged into the northeastern corner of the state. Apparently the Pit River Indians and northern Piutes knew the animal well. It has been extinct for three quarters of a century.

A pioneer named Belding went into the markets of Stockton in the year 1882 and there found two kinds of swans, the trumpeter swan and the smaller whistling swan. The latter still comes to the state in numbers each winter, but the former has not been recorded since that early date. A white-haired pioneer of the Surprise Valley in Modoc County once recounted to me his early experiences and told me of the countless thousands of "prairie chickens" found in his vicinity in early days. He said the Indians took a fair share of them but when the white man came, he hoggishly tried to see how many he could kill in a day in order to brag about it to his comrades. As a result, the Columbian sharp-tailed grouse has disappeared entirely within the state and there is no record of its occurrence within the last twenty years, though it is still found in a few neighboring states.

Reference to an abstract of the game laws will show

that there are many candidates for extinction. All of the large game mammals with the exception of the deer have been placed on the shelf, so to speak, for safe-keeping. Elk, antelope and mountain sheep are given protection the year around. Many fur-bearing animals, including the wolverine, fisher and beaver, are in imminent danger of extermination. Likewise, there is a long list of game birds that are given total protection and many others that show great reduction in numbers. Only one non-game bird, the condor, belongs in this list of disappearing species.

That most-feared-of-all horseman, Death, has reaped and continues to reap within our State.

The four horsemen, War, Famine, Pestilence, and Death, continue to sweep across California and they leave behind them devastation. They are at work taking our natural resources from us, natural resources which constitute the most dependable source of raw materials, without which man cannot exist. It is not easy to block the depredations of these four horsemen, but until they are driven from the state our resources will continue to wane. An army of defense must be recruited. To this trained army comes the task of driving these despoilers from the land. Then must come days of rehabilitation.

Some may say, is there any hope of doing anything? Here are some animals gone and many going; everything seems to be against them. Is there any hope? There are two points of evidence in this regard, and I think both of them show that if there is action favorable results can be expected.

Some years ago, Vermont found she had practically no deer. A few sportsmen decided it was time to act. They collected some money and purchased about fifty white-tailed deer, Virginia deer, turned them out in the mountains of Vermont and then passed and enforced

stringent laws. In twenty-five years deer again became common in Vermont. About 600 were taken the first year that the season was opened. Now the annual kill ranges between two and three thousand deer and we are told that there are more deer in Vermont, considering its size, than in any other New England state. When intelligent action was taken, worth-while results followed.

Game has wonderful powers of recuperation when it is given the chance. A few years ago when mountain quail had almost disappeared from the mountains of California, the state established a closed season for five years. At the end of that time quail had come back to about the normal numbers. Such results lend encouragement.

Values

The evident values urge endeavor. If our wild life resources had no particular value we might not care if they were wholly destroyed. However, there are four tangible values that pertain to wild life and other natural resources. Wild life has a money value—a certain worth in dollars and cents. We kill, each year in this state, 20,000 deer. Each is worth, at a minimum valuation, thirty-five dollars just for use as food. In 1912 there were sold in the markets of San Francisco alone, 300,000 ducks. We kill each year in this state about one million ducks. At a minimum value of twenty-five cents on each duck (many formerly sold for a dollar or more), we are able to estimate approximately what the crop is actually worth each year in dollars and cents. Trappers receive more than a quarter of a million dollars annually from the sale of furs. Furthermore, game resources attract people from other states, which brings money here. Think of the thousands of dollars spent every year just for ammunition and travel. This all has a dollar-and-cents bearing on our natural resources.

Certain other values should not be overlooked. Wild life has an esthetic value. People enjoy seeing living things around them. Many people choose their summer homes with reference to birds that sing in the vicinity. Many choose their vacation according to the interesting forms of life to be seen. People who visit Yellowstone National Park are more interested in the bears than in the geysers. The song of a meadowlark has cheered many a lonely country roadside. It is no wonder that many a hunter gets what is called "buck fever" when he sees a deer bounding up a hillside, for he cannot help being thrilled by such a sight. We must not overlook this esthetic value. Unfortunately, at the present time, there is an over-emphasis placed upon the monetary value. Too often, the entire valuation is placed upon the sordid basis of dollars and cents.

Living things have another value, an educational value. Most of the information that we have about our own bodies comes from the scientific study of living things about us. We know about our circulation, respiration, and nervous system because we have been able to study other living things and compare them. We can learn how better to order our own lives by a study of living things about us. They teach us a great deal if we will but let them.

Lastly, there is a fourth value which is difficult to put into any apt word or phrase. It is a social or religious value; religious because there is a certain sacredness which attaches to these living things, for when once they are destroyed no person can bring them back again. Most people are familiar with the famous building, constructed of marble, known as the Taj Mahal, in India. Suppose an earthquake were to level this famous building to the ground. There are descriptions, photographs, and there are architects and engineers who could actually rebuild

that building as well as, perhaps even better than, it was originally. But where is there anyone who can bring back to us any species of animal once it has been exterminated?

There are then at least four values—perhaps many others—the dollar-and-cents value, the esthetic value, the educational value, and, lastly, this certain sacred value, which idea, of course, is based on the fact that we owe something to those who come after us.

Conservation Projects

During the days of reconstruction, attention must be given four important projects: legislation, propagation, introduction and education. Herein lies the hope of the future.

Legislation is the time-honored method, the method most widely utilized, and yet legislation does not always bring the very best returns because it comes too slowly. The first law in California which had to do with game was an edict by a Spanish Governor prohibiting the Indians from trading in sea otter skins. Yet the sea otter, the most valuable fur-bearer in the world—and California was one of the few states that could boast of that valuable fur-bearer—received no legal protection until 1913, at which time it was practically extinct.

The band-tailed pigeon—a near relative of the famous passenger pigeon of the east, and a slow breeder, usually rearing but one young bird—received no protection at all in California until 1913. Men could legally kill pigeons when they were feeding their young, or might kill any number and ship to the markets. And even when protection was given the pigeon, it was the Federal government and not the State of California which took the first step.

This proves that sometimes the legislative method

is too slow to be effective. Yet much has been accomplished by it. First of all, laws give protection to animals on their breeding grounds. A toll of game animals can be taken only in the fall after the young have been reared. There are limit laws as well. We allow the taking of only buck deer in this state, and there is a further limitation, for the deer must be over one year old, that is, must have antlers that are branched. Perhaps the best of all is the provision by law for game refuges. There have been established in the State of California, twenty-eight game refuges, which form a chain reaching from the Oregon line to the Mexican line and comprise with the national parks about three million acres. Game is allowed to breed and to increase inside these protected areas and eventually it becomes more abundant, spreads to surrounding territory, and thus furnishes food and sport. So long as we keep these refuges inviolate we may expect to have a supply of breeding game. One of our main hopes for the future seems to be found in these areas where game is absolutely protected. Furthermore, we do not allow immigrants from the south of Europe to come here and, by setting their silk nets, trap our valuable song birds. Much, therefore, has been accomplished by means of legislation, but there is still more to be done.

The second method is that of propagation. This is a method that has proved very successful in the case of fish. Millions of fish are annually reared in state hatcheries and placed in depleted lakes and streams. The output in 1922 was forty-eight millions of trout and salmon. Apparently, we are successful here because we are dealing with a vertebrate form which lives in a constant medium, and which, therefore, is not subject to great changes in temperature as are birds and mammals. We have attempted the same thing with reference to game by establishing game farms. Thousands of pheasants and

hundreds of quail are annually reared and the successful stocking of lowland cultivated areas with pheasants is fast becoming a routine affair.

Yet the propagation of game birds and mammals is a far more difficult thing than the propagation of fish, and it will take many years of experimentation to establish the industry as firmly or attain an output sufficient for the needs of the state. Even when dependable methods have been found, only a partial solution of the main problem has been attained, for native species become competitors and numerous problems arise.

A third method is that of introduction. Here again we have been very successful with fish, as witness such introductions as the striped bass, black bass, shad, crappie, and many varieties of trout; but not so much so with game. The ring-necked pheasant is the only acclimatized foreign game bird and the opossum the only acclimatized game mammal, if game it may be called.

A great deal of time and energy is always spent in the introduction of foreign birds and animals in the attempt to increase sport. In the acclimatization of fishes and in the attempt to introduce foreign game birds, there have been many failures. Chinese quail, bob-white, and Mexican wild turkeys are nowhere found breeding in California, although numbers have been introduced. Such failures are overlooked in view of such successes as the ring-necked pheasant. Experience and better methods make favorable results with new ventures more probable. But there is danger of being misled in this matter of introduction. It is a dangerous method. Exotic plants and animals have a bad habit of getting a hold on new conditions that make them pests and a menace to native competing species. In the valley quail, the state has the best upland game bird in the West. To try to acclimatize a competing species would jeopardize our native quail. Usually one of two

things happens with this method—*either a great deal of money is wasted because of poor results, or the introduced species becomes a pest by destroying crops or usurping the food and the breeding places of our native species.*

Under the false idea that reduced stock needs new blood to prevent inbreeding, New England states imported southern bob-white quail. The present hybrid bird is said to be much less hardy and biologists cannot find specimens of the original native stock. California faces similar conditions, for Mexican quail are being imported promiscuously and liberated in covers supporting native stock. Trout at the head of the Santa Ana River in Southern California have been named a separate variety. In more recent years pack-train loads of rainbow and steelhead trout have been placed in the habitat of the San Gorgonio trout and as a consequence the native stock has been replaced by a hybrid fish which is certain to be of less interest and value.

The chance introduction of the opossum already mentioned is typical of the real danger that may be expected through poorly advised desire for non-native species. This animal is sure to give increasing trouble, for, an omnivorous feeder, it climbs fruit trees and eats the fruit, eats the eggs and young of birds, and breaks into rabbit hutches and poultry yards, destroying domestic animals and birds.

Study will show that the introduction of foreign species is a very dangerous method of increasing the supply of game, for there is always the chance of a waste of money in the failure of the species to get started, or if it becomes acclimatized, like the English sparrow, the starling, the mongoose and the opossum, it is likely to become a real pest. Great care should be taken in the utilization of this method.

Lastly, I come to the most important of all: the method

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of education. It seems reasonable that when people know conditions as they are, they will take proper interest in game and other natural resources and see that they are protected; they will take an interest in seeing that laws are enforced. This method ought to be the background for all other methods.

America is very far behind European countries in this regard. Nature study is taught in every public school in central Europe. Even the blind children are taken afield and taught to recognize birds by call note and song. In California we once had a law requiring that nature study be taught in every public school, and yet where was the subject adequately taught? The law has been rescinded and teaching of the subject is left to the whims of the county boards of education. Ask any college student some simple question about birds or animals and you have sufficient proof that he has had no proper teaching in the public schools. If even college students do not know the natural resources of their own state and the means to be taken to conserve them, how can the problem be met?

Someone has said: "Bringing an appreciation of the importance of conservation to the background of human consciousness is a work which cannot be done by one man or one organization in one year, or by many men and many organizations in many years." In other words, it must be brought about through a process of education. By this process alone can we expect to prevent unnecessary losses in exploiting natural resources and stimulate improved methods of perpetuating the resources which are renewable.

Man too often disregards the past and fails to think of the future. What nature has taken thousands or millions of years to produce, man destroys in a day. Living forms of both plants and animals have been brought to their

present status through a selective process which paleontologists can trace through eons of time.

A concrete example: A cattleman in the foothills of the Sierra Nevada recounts the results of an experiment in restoration of an over-grazed meadow. He purchased the best advice obtainable from university experts and followed directions. At the end of eight years of endeavor he was ready to state: "The best I have been able to do is to grow a poor crop of weeds." Man is just awaking to the fact that he cannot barber a forest or practically exterminate some species of game and then replenish the supply of these assets with a turn of the hand. The cycles through which each living thing has passed to attain its present form must be reenacted and that takes more time than man apprehends. Appreciation of this time factor should make us alert to utilize natural resources with care and understanding.

The ultimate source of supply of needed materials of civilized man is to be found in natural resources. Transportation is dependent on mines and mining; food supply and clothing on plants and animals; construction on forests, and even proper recreation on forests and wild life. Yet the idea seems to be growing that man can live by his own ingenious artifacts. When unusual conditions arrive, such as famine, or hard times, or war, then we are brought forcibly to view the real source of prosperity, of man's accomplishment. Most of the time we see manufactured products, artificial handiwork, and overlook the true source of the materials. As a result of this incomplete view-point, we continue to allow wastage of these sources, taking little thought of their exhaustibility and the impossibility of their replacement. Eons of time have been utilized in bringing the earth to its present stage, and replacement of natural resources is not a simple or a quick achievement. A crop or share of each may be

harvested and the resource continue, but deplete it and the time element precludes restoration and use during a generation or a series of generations.

There must be inculcated into every mind the idea that science is conservation insurance. Knowledge of life history and habits, of rate of growth and death rate, form the basis of all wise administration of wild life resources. The use of applied science in the solution of conservation problems is a great hope of the future.

The following outline sums up the main points made:

1. We have been wasteful of our forest and wild life resources. The four horsemen—War, Famine, Pestilence and Death—continue to lay waste our resources.

2. In California, we have exterminated two valuable game animals and two valuable game birds and there are many candidates for extinction.

3. Many factors have been involved in game decrease, including man, reclamation, increased efficiency of firearms, the automobile, and predatory animals—of which undoubtedly man is the most important.

4. Something can be accomplished if there is action, as is evidenced by Vermont's experience with deer and California's experience with the mountain quail.

5. The methods which can be best applied are: The method of legislation, time-honored but oftentimes too slow to be effective in results; the method of propagation, so useful in the case of fish, but thus far much less useful in the case of game; the method of introduction, found useful in the case of fish, but particularly dangerous in the case of game; and, lastly, the method of education—fundamental, and the method in which all may take part.

Natural resources do not belong to the individual but to the commonwealth, according to many decisions of the Supreme Court. Consequently, forests and wild life

constitute resources that are ours to use but not to destroy, for we must pass on this heritage undiminished to future generations. Natural resources must be made to last through the ages.

"Whate'er the gifts o' gods to men,
Whate'er the blessings men enjoy,
The gods ne'er give those gifts again,
Nor re-create what men destroy!"

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CHAPTER II

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CHAPTER III

Reference to the accounts of the early exploring expeditions not included in the following bibliography will bring word-pictures of the great interior valley in its original state. J. D. Whitney in the Geological Survey of California, already mentioned twice, gives a short description. Accounts of the various wild flowers are to be found in Armstrong and Parsons and Buck, a more technical treatment in Jepson. For a treatise on weeds, refer to Smiley. Grinnell and Dixon have given us a full account of the life history of the ground squirrel; habits of wood rats are detailed by Anthony, Parks and Taylor. Acquaintance with the chaparral is easy when Francis Fultz' *Elfin Forest* is used. One should also refer to Plummer's classic work. Savin and Shay describe the yucca. For further information on the condor, reference should be made to articles in *The Condor* by Finley; on the acorn-storing woodpecker to those by Henshaw and Ritter.

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CHAPTER IV

A book relative to the Sierra Nevada published in 1872 is still a classic. It was written by a member of the State Geological Survey. Clarence King climbed most of the higher peaks in making explorations and this gave him material for his *Mountaineering in the Sierra Nevada.* Whitney's report gives further geological details. J. M. Hutchings published *In the Heart of the Sierras* in 1888 and made known by picture and story the wonders of the central Sierra. Of still more pertinent value than Hutchings' work to anyone contemplating a Sierran trip are the volumes by John Muir, especially *The Mountains of California*, and *My First Summer in the Sierra.* The two volumes on *The Life and Letters of John Muir* by William Frederic Badè are complementary. Pertinent chapters on natural history are to be found in Hall's *Handbook of Yosemite National Park;* but the fuller account will be found in the splendid large volume entitled: *Animal Life in the Yosemite* by Grinnell and Storer. The handiest volume on the botany of the Sierra is that by H. M. and C. C. Hall. *The Sierra Club Bulletin*, and *Trails*, the latter the publication of the California Alpine Club, contain numerous worth-while articles.

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CHAPTER V

The most delightful introduction to a study of the southwestern desert is to be found in Van Dyke's *The Desert*, with Chase's *California Desert Trails* a close second. A more technical treatise is that of Buxton: *Animal life in deserts*. *Denizens of the Desert* by Jaeger brings a pleasing series of personal adventures with the animal life. Some interesting biological problems have been outlined by Sumner. Grinnell lists the vertebrate fauna of the desert in his Colorado River and Death Valley papers. Numerous articles relative to the plant life have been published in various periodicals.

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CHAPTER VI

There are three major reference works dealing with California trees: *The Silva of California* and *The Trees of California* by Willis Linn Jepson of the Botany Department of the University of California, and *Forest Trees of the Pacific Slope* by George B. Sudworth; the latter is obtainable from the Superintendent of Documents, Washington, D. C., for the small sum of $0.60. The volume is splendidly illustrated and gives detailed descriptions and distribution of each California tree. *The Elfin Forest* by Francis M. Fultz gives one a good understanding of the make-up of the chaparral. Ellsworth's *The Giant Sequoia* is a dependable recent volume on the big trees and it contains a full bibliography. Pertinent articles on trees and forest conservation may be found in the magazine *American Forestry*, now *American Forests and Forest Life*. Bulletins by the Forest Service cover habits of many different trees and measures for their protection.

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CHAPTER VII

Most of the knowledge regarding fresh water fishes of California has come as a result of research at Leland Stanford, Jr., University. David Starr Jordan, now the Chancellor, first codified knowledge regarding the various trouts of the Pacific Coast. Dr. Barton W. Evermann, Director of the California Academy of Sciences, published the first report on the golden trout. Dr. Hugh M. Smith, formerly United States Commissioner of Fisheries, has summarized the attempt to acclimatize fishes in California, as has also W. H. Shebley. The best general treatise for reference is Jordan and Evermann: *American*

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CHAPTER VIII

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CHAPTER IX

Such books as James' *Our American Wonderlands*, Allen's *A Guide to the National Parks* and Muir's, Mills' and Yard's volumes on national parks will bring general information. More specific are the circulars of information issued on each national park by the National Park Service. For a general work on national forests refer to Boeker. A Forest Service bulletin on *The National Forests of California* by Ayres and Hutchinson gives a good picture of the forest reserves of the State. Numerous pertinent articles have been published in the *National Parks Bulletin* and *American Forests and Forest Life*. Developments in forestry policy in California and of park extension may be traced in discussion found in the *Sierra Club Bulletin*.

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CHAPTER X

A splendid introduction to the general study of recreation is to be found in Viscount Grey's, *Recreation*, a lecture delivered to Harvard students. Discussion of mountaineering in California will be found under the authorship of Clarence King and Joseph Le Conte. Leroy Jeffers' *The Call of the Mountains* is a more general work. A. W. Palmer's *The Mountain Trail and its Message* is a choice little publication, but one difficult to find. The *Sierra Club Bulletin*, and *Trails*, a publication of the California Alpine Club, contain many descriptions of mountain trips. The thrills of mountain climbing and discovery are given charmingly by Clarence King. Naturalist's field experiences are to be found in the works by Chase and Saunders.

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CHAPTER XI

Surprisingly few references of import are to be found relative to conservation in California. For a general work on forestry conservation one may turn to Van Hise. Two volumes by William T. Hornaday bring a vision of the needs for wild life conservation. Evermann's articles deal with the protection of marine mammals. *The Game Birds of California* by Grinnell, Bryant and Storer has much to say of conservation. Shorter articles have appeared from time to time in various sporting and outdoor magazines. Particularly pertinent to California are papers by Taylor and Evermann and the numerous articles that have appeared in *California Fish and Game,* the quarterly publication of the California Fish and Game Commission.

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